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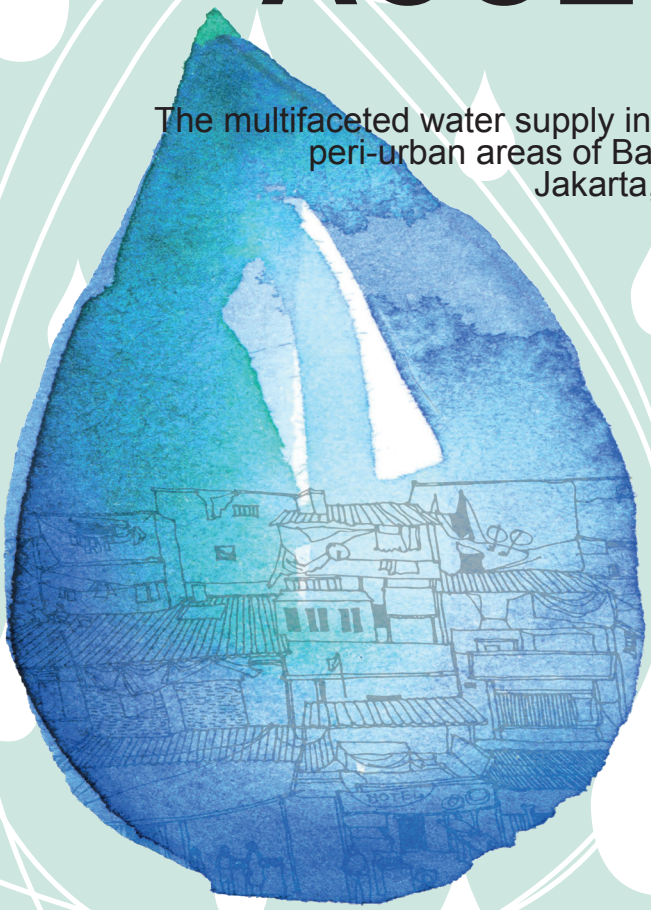
The multifaceted water supply in urban and peri-urban areas of Bandung and Jakarta, Indonesia



Anindrya Nastiti

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This research was part of a double degree program between the Institut Teknologi Bandung, Indonesia, and Radboud University, the Netherlands,and conducted at the department of Environmental Engineering, the Faculty of Civil and Environmental Engineering of Institut Teknologi Bandung and the Institute for Science, Innovation, and Society (ISIS) of Radboud University. The research presented in this thesis was financially supported by the Directorate for Higher Education (DIKTI) Indonesia, Institut Teknologi Bandung, Radboud University, and Deltares.

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Proefschrift

ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen
op gezag van de rector magnificus prof. dr. J.H.J.M. van Krieken

volgens besluit van het college van decanen

en aan het Institut Teknologi Bandung
op gezag van de rector magnificus prof. dr. ir. Kadarsah Suryadi DEA,

in het openbaar te verdedigen op woensdag, 20 september 2017
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Anindrya Nastiti

geboren op 17 oktober 1984
te Bandung, Indonesië

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Doctoral thesis

to obtain the degree of doctor
from Radboud University Nijmegen
on the authority of the Rector Magnificus prof. dr. J.H.J.M. van Krieken

according to the decision of the Council of Deans

and from Institut Teknologi Bandung
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to be defended in public on Wednesday, September 20, 2017
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"Read! In the name of thy Lord who created man from a clot. Read! And thy Lord is the Most Generous Who taught by the pen, taught man that which he knew not." (Quran, 96:1-5)

Dedicated to Arkadipta Bagastama and
Abisakha Satyamanggala

CONTENT

GLOSSARY

access to water	access to water is defined as having some types of “improved” water sources at home. Access is often measured by the percentage of the population using improved drinking-water sources
aversion behaviours	actions taken by households to mitigate damage associated with pollution. This concept has been previously used to measure economic losses in response to environmental externalities. This dissertation extends the scope of aversion behaviours not only actions seeking to avoid health risk, but also strategies aimed at uncertainty reduction and avoidance of economic loss.
branded bottled water	mineralized and demineralized drinking water produced by beverage companies. Water can be sold in 600 mL, 1 L, and 19 L bottles. This type of bottled water is priced from IDR 13,000 (US$ 1.1) to IDR 15,000 (US$ 1.2). The bottled water industry is tightly regulated by the Ministry of Health and Consumer Protection Agency and adheres to a quality assurance standard to ensure safety.
City	the level of an administrative area under province in which the area consists of mostly “urban”. A city is headed by a mayor. This area has the same level with “regency”. A city consists of several districts.
co-production	the process through which inputs used to provide a good or service is contributed by individuals who are not in the same organization. Scholars mostly use the term “co-production” in the context of the collaborations between state and non-state actors in producing public service. This dissertation applies this notion to the collaboration between private actors, community actors, and households in producing service of water supply.
dimensions of access	different aspects of water provision: physical access, quality, quantity, continuity, and affordability. Drinking water should be provided in close proximity to dwellings thus prevents excessive collection time. Water must be free from contaminants posing a health risk to a person. Water should be adequate and continuous for drinking and maintaining hygiene. Costs related to water should not prevent a person from accessing safe drinking water and should not restrict him or her to enjoy other basic rights. The concept of equity enters the notion of the dimensions of access in the post-2015 water framework.
district	an administrative area under city or regency. A district consists of several *kelurahan* or villages.

improved-unimproved water source	an improved drinking-water source is defined as one that, by nature of its construction or through active intervention, is likely to be protected from outside contamination, in particular from contamination with faecal matter. In the JMP water ladder, improved water sources consist of piped water on-premises, protected dug well, borehole, rainwater harvesting, and protected spring. Meanwhile, unimproved water sources include: unprotected dug well, unprotected spring, surface water (river, dam, lake, pond, stream, canal, irrigation channel), vendor-provided water (cart with a small drum or a tanker truck), bottled water (classified as unimproved due to the issue of sustainability, bottled water is considered improved when the household use another improved source for cooking and personal hygiene).
kelurahan	the smallest administrative area under a district.
mitigating behaviours	see “aversion behaviours”
pangkalan	a station in which the activities of spring water pumping to reservoir and spring water sale take place.
piped water on premises	water provided by the municipal water company, which delivers water through a piping network directly to houses.
refill water	drinking water sold by small kiosks (refill water kiosks or water refilling stations) that treat raw water sources by using filtration sets and ozone/UV disinfection units. The treated water is supplied in refillable 19-L plastic bottles and sold directly to households. Regulations require refill water kiosks to register with the local health office and pass water safety and sanitary inspections. The cost of this type of drinking water is much lower relative to branded bottled water at only IDR 3,500 (US$ 0.3) to IDR 5,000 (US$ 0.4).
regency	the level of an administrative area under province in which the area consists of mostly “rural”. A regency is headed by a regent. This area has the same level of “city”. A regency consists of several districts.
South-North	the North–South divide is broadly considered a socio-economic and political divide. Generally, definitions of the Global North include the United States, Canada, Western Europe, developed parts of Asia, Australia and New Zealand. The Global South is made up of Africa, Latin America, and developing Asia including the Middle East.

Chapter 1

General introduction

1.1 Man, Cities, and Water

Human settlements dawned around the availability of fresh water sources. The emergence and development of cities –the centres of economic and socio-cultural activities– in the history of humanity brought about the logistical challenges of bringing water from distant sources. In 2030, cities will contain almost five billion people, where 80% are concentrated in developing nations, particularly in Asia and Africa (UNFPA, 2007). In Indonesia, one of the fastest growing nations of Asia, the most vital issue of this century is to cope with the fast growing demand for freshwater services in urban areas. The cities' water problems are also not only about transporting water, but also to ensure that the water supply delivered to urban citizens contributes toward the intended positive development outcomes. The water supply sector seems to largely focus on supply-oriented provision through expanding physical access. For instance, the target of the first Drinking Water and Sanitation International Decade was interpreted by most sector agencies as a mandate to construct as many new systems as possible (O'Rourke, 1992). However, the objectives of providing a water supply lie beyond physical access but rather to maintain dignity, protect people's health, and avoid the excessive costs that prevent people from enjoying other basic needs. Poor water supplies have long been associated with water-related diseases, chemical exposure, and indirect health impacts resulting from reduced productivity and poor personal hygiene (Hunter et al., 2010). Nevertheless, Mehta et al. (2007) argue that enhancing physical access is not enough; one should also consider "functionality", which refers to the extent to which access enables people to gain positive personal, social, and economic outcomes.

"The cities' water problems are also not only about transporting water, but also to ensure that the water supply delivered to urban citizens contributes toward the intended positive development outcomes."

In the supply-oriented provision, a centralized piped water supply system that delivers potable water to premises is viewed as the ideal mode of provision (Furlong, 2014). Piped water, by far, may be the most efficient technological outlet to deliver water to densely populated cities and this technology remains the long-term goal for water supply sector development. Yet, for more than half of the population of developing regions, this infrastructure ideal is a hard-earned luxury: only 48% of the people of these regions had access to piped water by 2012 (UNICEF & WHO, 2014). For example, in Indonesia, piped water supplies only served 15.27% of the total population by 2009, and this percentage decreased to 10.20% in 2015 (Ministry of National Development Planning, 2010; National Statistical Office, 2015). Although in most developing countries, there was a striking increase in the coverage of piped water to premises, the balance between the increases in piped water on premises and increases in other improved sources has varied widely between regions (UNICEF & WHO, 2015). In South-east Asian countries, increased access to wells and springs contributed the most to realising the Millennium Development Goals (MDGs). Indeed, in the urban South, non-piped water sources are not merely an "alternative" to piped water but often serve as the dominant mode of water provision. While the larger part of many centralized water networks is managed by the public sector, there are many diverse institutional arrangements that make up the "alternative" provision systems.

This research highlights what's beyond physical access to water and reveals the complexity of water provision in urban and peri-urban areas. This includes the

functionality of water, the outcomes of water provision, and the diverse range of non-state provision systems, also referred to in this research as “multifaceted access”.

1.2 Multifaceted Access to Water in the Urban and Peri-Urban Areas.

As a guideline for this research, Figure 1.1 shows a generic framework of water supply provision depicting the multifaceted nature of urban and peri-urban water provision.

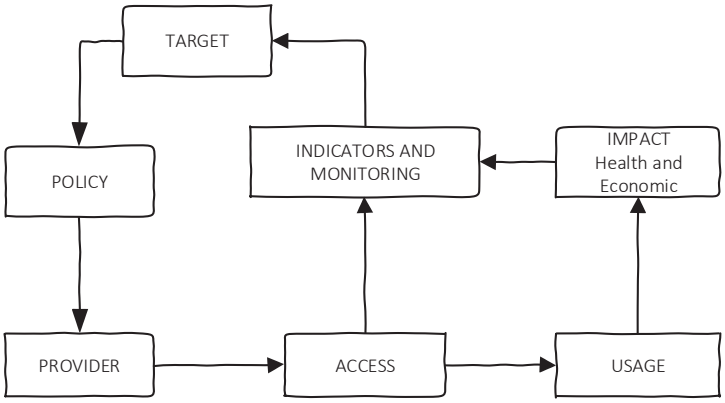


Figure 1.1 A generic framework of water supply provision.

(a) Provision

First and foremost, water supply service may be produced through various institutional arrangements. At present, the state plays a dominant role in middle- to low-income countries, providing water for 90 percent of the largest cities (Hall & Lobina, 2006). The state may be present in the form of either highly centralized government agencies or decentralized local organizations (Allen et al., 2006). The Indonesian regulation implies that water supply must be managed by the state through state-owned companies or government technical units (Government of Republic of Indonesia, 2015). Municipal water companies (MWCs) are responsible for providing water services in the majority of Indonesian cities; however, these companies face the high operation and maintenance costs of large-scale centralized piped water systems, limited budgets, and managerial problems, leaving a large proportion of the Indonesian population underserved (Firdaus et al., 2012).

In the private sector, the drinking water system ranges from large concession to small-scale providers (Ahlers et al., 2013; Opryszko et al., 2009; Pierce, 2015). Large-scale concession started to develop in the urban water supply sector in the late 1980s (Hall & Lobina, 2006). The World Bank and donor agencies expected water privatization schemes to provide more efficient service and a better form of governance, compared to services provided by the public sector, which was associated with corruption and inefficiency (Hall & Lobina, 2006). Even so, like in the case of Jakarta, the capital city of Indonesia, water privatization schemes have not been successful in solving the problems of water accessibility and service quality, particularly with respect to access for the underprivileged (Bakker et al., 2008). For instance, private sector participation may reduce water affordability as a

consequence of tariff increases (Bakker et al., 2008). Moreover, with the increasing popularity of bottled water products, bottled water producers, from multinational companies to small refill kiosks, have become an important private sector producer of drinking water in Indonesia. In the urban and peri-urban South, small-scale water entrepreneurship is increasingly the ascendant water providers for the underserved poor. This type of water vending accounts for a large proportion of total water revenues and is no longer a fringe activity (Gulyani et al., 2005).

In reality, however, citizens access water through multiple modalities, often combining state-led and private-led provisions. Schwartz et al. (2015) demonstrated a meshwork of service provision by different, interdependent providers. Frequently, these provision systems are outside the scope of the formal system. For example, Allen et al. (2006) documented that the water supply network and formal provision system in the peri-urban areas of Dar es Salaam, Cairo, Mexico City, Caracas, and the Greater Cairo Region are unsatisfactory; therefore, the peri-urban poor then rely on needs-driven forms of supply, which resulted from poor people's efforts to gain access to what the formal system could not supply. Kooy (2014) argued that all these informal means in the urban water supply sector should be understood not as a state or development failure to achieve the urban infrastructural ideal, but rather as a particular mode of urban development that is reliant on a range of informal practices.

(b) Physical access

In this dissertation, physical access to water refers to the classification of the WHO and UNICEF's Joint Monitoring Programme (JMP) –the United Nations' mechanism to monitor progress in the water and sanitation sector (Figure 1.2).

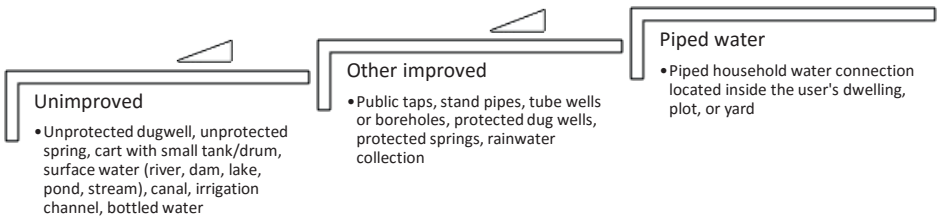


Figure 1.2 The JMP's three-step ladder indicating the classification of the levels of access to water (UNICEF & WHO, 2008). Bottled water is considered "improved" only if water for other domestic purposes originates from some kind of improved source.

The JMP classifies water supply sources into piped water in premises, other improved sources (i.e., protected dug well, borehole, protected spring, and rainwater harvesting), and unimproved sources (i.e., unprotected dug well, unprotected spring, bottled water, and water from vendors). Having access to water means having some types of "improved" water sources at home. "Access level" is often measured by the percentage of the population using improved drinking-water sources. At the global level, the present monitoring framework focuses on measuring the level of access: the proportion (un)served by improved water sources. Indonesia had the fifth highest proportion of the population without access to improved water sources globally (UNICEF & WHO, 2012); yet these classifications merely serve as a proxy indicator

and only encapsulate the technological outlets of household water sources and do not equal safe water (UNICEF & WHO, 2011). Physical access may not necessarily lead to the sustained use of improved water sources nor bring the intended development outcomes, i.e., health and economic benefits. Since the 1980s, it was recognized that the positive health impact from "access" to improved water sources can only emerge when it is related to "functionality". For example, Esrey et al. (1988) concluded that in Lesotho, improved drinking water supplies could benefit the health of preschool children after infancy, but only if the water supplies are functional and utilized for drinking and cooking purposes.

(c) The dimensions of access

In addition, access comes with various ranges of quality, quantity, continuity, and affordability; the so-called "dimensions of access" (Nganyanyuka et al., 2014). Even when people have access to piped water, it often has inadequate quality and quantity, is intermittent, or is unaffordable (Lee & Schwab, 2005; McGarvey et al., 2008; Tshikolomo et al., 2012; Zérah, 1998). Studies focusing on the dimensions of access are well established, such as safety (Gundry et al., 2006, O'Hara et al., 2008), affordability (Cheng, 2013; Zawahri et al., 2011), and continuity or reliability (Kjellén, 2006; Kyessi, 2005; Zérah, 2000). The most widely studied aspect is the issue of water quality. The recent, wide-scale Rapid Assessment of Drinking Water Quality (RADWQ) in five countries, Ethiopia, Jordan, Nicaragua, Nigeria, and Tajikistan, measured the compliance of different water sources with standards for bacterial and geogenic or natural contaminant levels. The RADWQ reported that 32 million out of 70 million people with access to improved water sources do not have water resources that comply with tested water quality parameters (Bain et al., 2012). These studies suggest that water supply often does not meet the requirements of good dimensions of access, even in the improved types.

Meanwhile, equity entered the "playing field" since the United Nations General Assembly explicitly recognized the human right to water and sanitation through Resolution 64/292 and the ratification of SDGs (Sustainable Development Goals) in September 2015. The concern over equity largely revolves around the uneven progress across populations, based on income, region, type of area (rural/urban), and the marginalization of the poorest (Fukuda-Parr & Yamin, 2013; Satterthwaite & Winkler, 2012; UNICEF & WHO, 2011). Globally, progress has been slowest in the least developed countries and other low-income countries, as 84% of the population without an improved drinking water source lives in rural areas; twice as many people in the urban areas of the developing regions have gained access to piped water than in rural areas, and the richest quintile is over twice as likely to use an improved drinking water source as the poorest quintile (UNICEF & WHO, 2011). A recent study in Bhutan concludes that wealthier households have access to safer water sources than their poorer counterparts, with both education and income as strong determinants for access (Bahadur et al., 2015).

(d) Usage

Not only does the lack of physical access affect citizens' health, the deficiencies of the other dimensions of access may expose urban citizens to various health and economic risks related to water. The problems in the dimensions of access have led to various strategies adopted by households. In the point-of-use strategy, citizens

often adopt a broad range of individual and collective strategies to obtain safe and reliable water for their daily needs (Allen et al., 2006). Mitlin (2008) provides a list of strategies in which citizens are positioned not as passive actors, but rather as active ones by being engaged in individualized or household market-based strategies, collective self-help strategies, dependency-based strategies, decision strategies, or social movement strategies. This dissertation consequently focuses on individualized or household market-based strategies and collective strategies. Meanwhile, dependency-based strategies (extending patron-client relationships between citizens and government officers), exclusion strategies (related to criminality), and social movement strategies (involving politicized mass action collectively undertaken by citizens) are outside the scope of this research since those strategies are too broad to be discussed in a single research study. According to Mitlin, individual strategies are comprised of individual advancement within the opportunities offered by existing structures and systems, whereas collective self-help strategies take place when the residents of a neighbourhood facing a common need come together to provide collective goods and services, usually with the absence of the state. Pursuing multiple sources of water, rescheduling activities based on the availability of water, home water treatment and storage, and even moving to another house with better water service have been documented as individual household strategies to secure access to a more reliable supply of water (Zérah, 2000; Adekalu et al., 2002; Pattanayak et al., 2005; Howard et al., 2002; Neumann et al., 2014; Morinville & Harris, 2014). In Dar es Salaam, citizens perform various strategies to obtain water, such as obtaining water from vending kiosks, tanks, and bore wells; walking long distances; buying from water trucks; buying many storage vessels; harvesting rainwater; obtaining water from local wells, springs, and swamps; domestic water budgeting; and making illegal connections (Rugemalila & Gibbs, 2015).

Strategies adopted to cope with problems in the dimensions of access are often mentioned as “aversion or mitigation behaviours”, which are expected to decrease the aforementioned health and economic risks related to poor dimensions of access. The widely assessed aversion behaviours are bottled water purchase and household water treatment to avoid health risks related to drinking water safety (Abrahams et al., 2000; Jakus et al., 2009; Nauges & Van Den Berg, 2009; Janmaat, 2007).

(f) Impact

The aforementioned aversion strategies or behaviours may mediate the health and economic impacts of inadequate water supply. Inadequate water supply quantity and quality, interrelated with human behaviour, contribute to an increased risk of poor health (Shaheed et al., 2014). Epidemiologic evidence shows that improvements in drinking water quality provide significant health benefits (e.g., Clasen et al., 2009).

All the strategies mentioned previously also entail expenses, which households often do not realize they are burdened with. Water expenditure mainly discusses the monthly water bill and often the proportion of income spent on buying water (Vásquez et al., 2009). At present, the discussions of the “real” water expenditure that acknowledges the costs related to household strategies revolve around averting expenditures related to perceptions of poor water quality (see Lanz, 2015; Wu & Huang, 2001). Previous studies offered methods to measure a wide range of health and economic impacts related to water. The focus of these studies was mostly directed on measuring the time cost and treatment-seeking cost related to

waterborne diseases (see, for example, Haller et al. (2007); Bahadur et al., 2015). Studies focusing on costs related to user behaviour in coping with poor water supply are limited. Two studies, conducted by Pattanayak et al. (2005) and Cook et al. (2016), estimated the coping costs, which in this dissertation are called the aversion or mitigation costs, resulting from a poor water supply.

(g) Indicators, monitoring, policy

Some scholars linked the multifaceted elements of water access with policy and monitoring strategies. For example, policies focusing on expanding the level of access towards "improved technologies" may lead to a higher concentration of hidden failures, e.g., technical non-functioning (Starkl et al., 2013). Onda et al. (2012) stated that when adjusting the current Joint Monitoring Programme (JMP) estimate by accounting for microbial water quality and sanitary risk, there was a shortfall of 10% of the global population towards the MDG target in 2010, suggesting that better attention to the water safety aspect is needed. Shaheed et al. (2014) mentioned that a better understanding of the complex behavioural factors surrounding the ways in which water is sourced and handled at the household level could help inform future interventions to promote optimal water use. Similarly, a full understanding of behaviour would also guide behaviour change interventions related to WASH (water, sanitation, and hygiene) (Dreibelbis et al., 2013). Grafton et al. (2011) suggested that understanding water expenditure related to the volumetric consumption of water can inform policy-makers regarding the most effective policy levers to regulate household water consumption. Policy makers need information on the households' knowledge of the quality of water from different sources before attempting to affect households' choice of water (Persson, 2002). Hurlimann et al. (2009) provided an extensive review of water-related behaviour, which the authors claimed to be essential to provide insight into water sources and water-related behaviour.

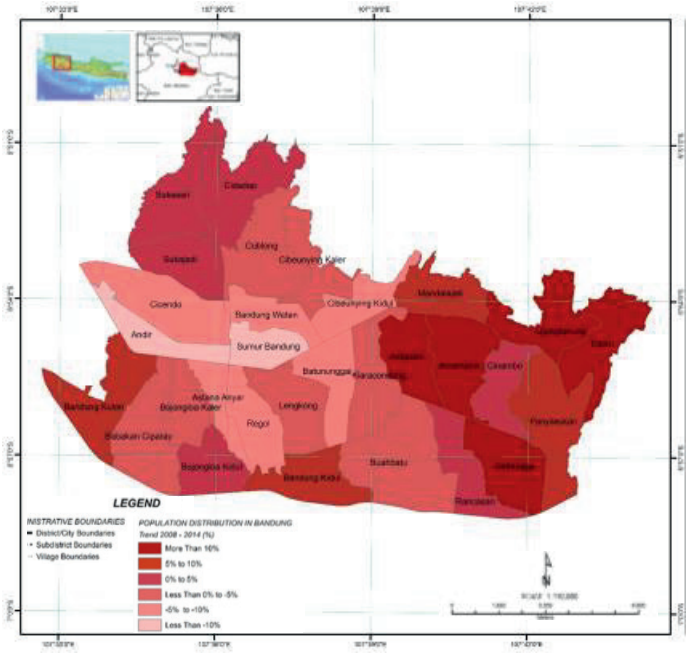
There is an urgent need to enhance our understanding of the multifaceted nature of access in Southern cities. This could inform both new policies and new approaches for monitoring these policies.

1.2 The Research Area: Bandung and Jakarta

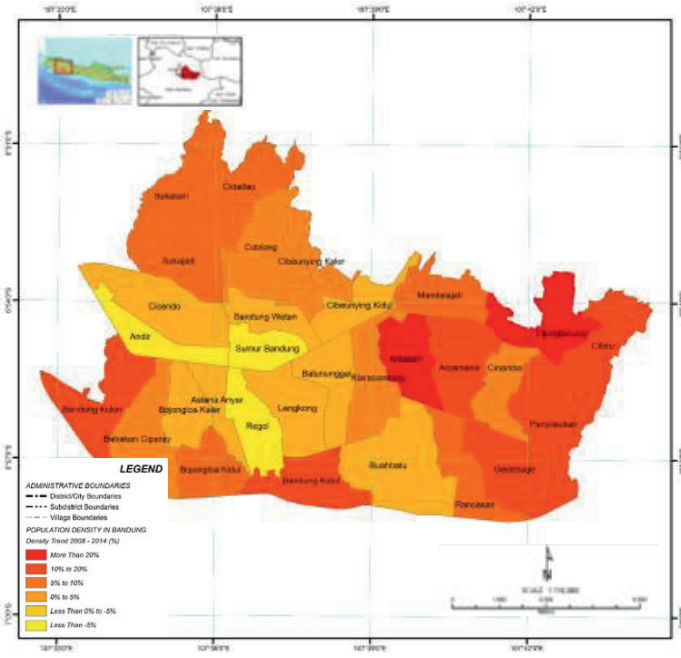
This research is mainly focused on Bandung City, the capital metropolis of West Java Province, Indonesia, located in the core of Bandung Basin. However, participants from Jakarta City were also involved in the study on bottled water perceptions to get more insight into different metropolitan areas in Java. This section provides information on demographic characteristics and the water supply in Bandung City and, albeit briefly, Jakarta.

With a total population of roughly 2.45 million, Bandung City grew at an average annual rate of 1.06% from 2007 to 2012 (Government of Bandung City, 2014). The population growth had slowed, compared to previous years; however, that does not necessarily reduce the pressure towards the city. The increasing commercial activities in the city and the rising property prices in the city centres pushed young families and the poor to the periphery of the city, even to the hinterland areas in the Bandung Basin. Figure 1.3 shows the distribution of the population and population density trend between 2008 and 2014 in Bandung City.

Bandung's piped water is supplied by a public water supply company (MWC) through individual network connections and non-network water supply through public taps and water tankers. The Regional Mid-term Development Plan in 2009-2013 states that the piping system serves 65% of the total Bandung population (Government of Bandung City, 2009). The latest Regional Mid-term Development Plan in 2014-2018, however, recorded that only 25% of the people can rely on the city's provided water (Government of Bandung City, 2014). The latest Plan also recorded that the number of house connections increased from 2009 to 2012, from 121,094 house connections to 141,094 house connections; however, there was no improvement in the growth of piped water coverage from 2009 (25.05%) to 2012 (24.98%) (Government of Bandung City, 2014). Figure I.4 shows the coverage of piped water in Bandung City. Meanwhile, the majority of the population relies on non-piped water sources, specifically wells and surface water. Water vending that previously existed primarily in the eastern part of Bandung has spread to the other parts of the city.



(a)



(b)

Figure 1.3 The growth of population distribution (a) and density (b) from 1998 to 2014, based on districts in Bandung City (data from Bandung City Statistical Office (2009) and Bandung Statistical Office (2015); map courtesy of Adi Jaya Putra).

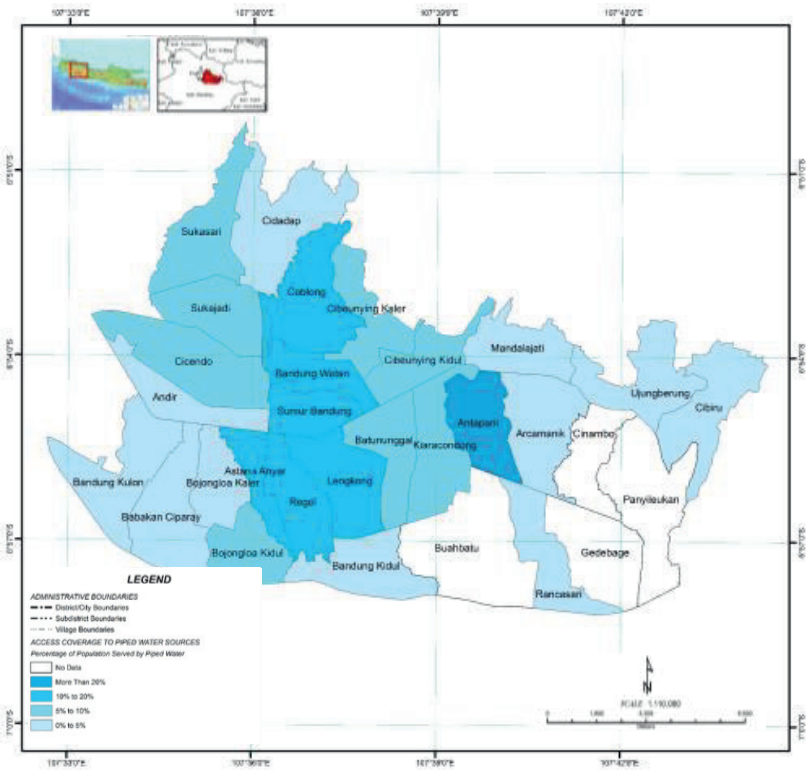


Figure 1.4 The coverage of piped water in Bandung City (data from MWC Tirtawening; map courtesy of Adi Jaya Putra).

The limited availability and poor quality of the raw water supply are the main challenges in supplying water to Bandung citizens. At the moment, the MWC relies on groundwater and surface water, located within and beyond the administrative area of the Municipality, as their main raw supply for water production. The MWC faces technical and non-technical water loss of 49-56% per year (MWC Tirtawening, 2010). From the total length of 2000 km, 400 km of pipelines were installed during the Dutch colonial era in the 1920s, 450 km were installed in the 1980s, and 1200 km were installed in the 1990s. The ageing pipes and the presence of asbestos pipes also contribute to the leakage problem.

Supply continuity has also been a problem. A rotation system –with the average distribution of 15 hours per day– has been established in almost all distribution areas, except northern Bandung, to ensure that all customers have their fair share of water. The MWC's sub-optimal service in providing water is mainly due to the following problems: limited production capacity, a low recorded volume in users' water meters, inaccurate data of distributed water volume, water loss in the pipeline system, inaccurate costumer data, illegal connections, contamination in distribution pipes, poor hydraulic systems in distribution pipes, disturbances in mini water treatment plants, broken transmission and distribution pipes, low raw water flow rates, and poor borehole quality (Government of Bandung City, 2010).

The inadequacies of the piped water supply encourage excessive ground water withdrawals from shallow and deep wells. The MWC's Masterplan in 2010 reported that there was a sharp increase in the groundwater abstraction rate, from 10.5 million m^3/year in 1970 to 66.9 million m^3/year in 1995, of which 92% was for industrial use; meanwhile, the increase in the number of boreholes was estimated from 500 units in 1970 to 2200 units in 1995 (MWC Tirtawening, 2010). The Mid-term Development Plan of Bandung City reported that 887 groundwater industrial extraction points with an abstraction rate of 1.1 million m^3/month were identified in August 2013 (Government of Bandung City, 2014). Although the actual number of boreholes is disputed, the estimates may be underrated, since illegal boreholes for domestic and industrial uses are generally expected to have increased. Pollution problems also frequently occur in boreholes and wells. According to the local health office, 50% of the examined dug and pump wells did not meet clean water requirements. Only 37% of the total household water samples taken from 52 villages in Bandung were classified as "clean water"; the remainder were contaminated with faecal coliform bacteria, some of which even extended to 2400 MPN (Most Probable Number) per 100 ml (Government of Bandung City, 2014).

Fieldwork in Bandung City is concentrated in three types of areas: slums, peri-urban areas, and riverbank areas. These areas were selected to highlight the urban populations at risk of lacking water supply service.

- Slum areas are a national priority for the Acceleration Program of the National MDGs' Target Achievement (Ministry of National Development Planning, 2010).
- Riverbank dwellers represent both socio-economic and geographic vulnerabilities. According to the Environmental Health and Risk Assessment of Bandung City, the riverbank districts included in the study area are classified as medium- to high-risk with regard to poor drinking water, sanitation, and health (Government of Bandung City, 2010).
- Peri-urban areas have also long gained special attention from water scientists and practitioners, considering its locus in the cities' fringe and distance from the centralized piped water connection.

Meanwhile, the study on the perceptual drivers of bottled water consumption conducted in this study involved internet users who not only live in Bandung, but also the Special Capital Region of Jakarta (see Figure 1.5). With a population of 9.9 million, the Jakarta metropolitan area is the centre of governmental affairs and trading, which extends beyond its satellite cities and metropolis suburbs area. Like Bandung, Jakarta's water supply was also provided by a public water company; however, effective in 1998, the Ministry of Public Works invited two international operators, Suez Lyonnaise des Eaux (France) and Thames Water International (UK), within a 25-year concession agreement (Lanti, 2007). Even so, the coverage of piped water from 2004 to 2015 provided around 50% of the city's water needs (Bakker, 2007; Kooy et al., 2016). Similar to Bandung City, groundwater and water from vendors remain the choice option to fulfil the daily water needs of Jakarta's households without (and, too often, those with) piped water. For drinking purposes, 71% of Jakarta's households use bottled water (Jakarta Statistical Office, 2016). Likewise, 65.8% of Bandung City's population drink bottled water (Bandung City Statistical Office, 2014). In both cities, bottled water became the most used drinking water source, compared to any other type of water source.

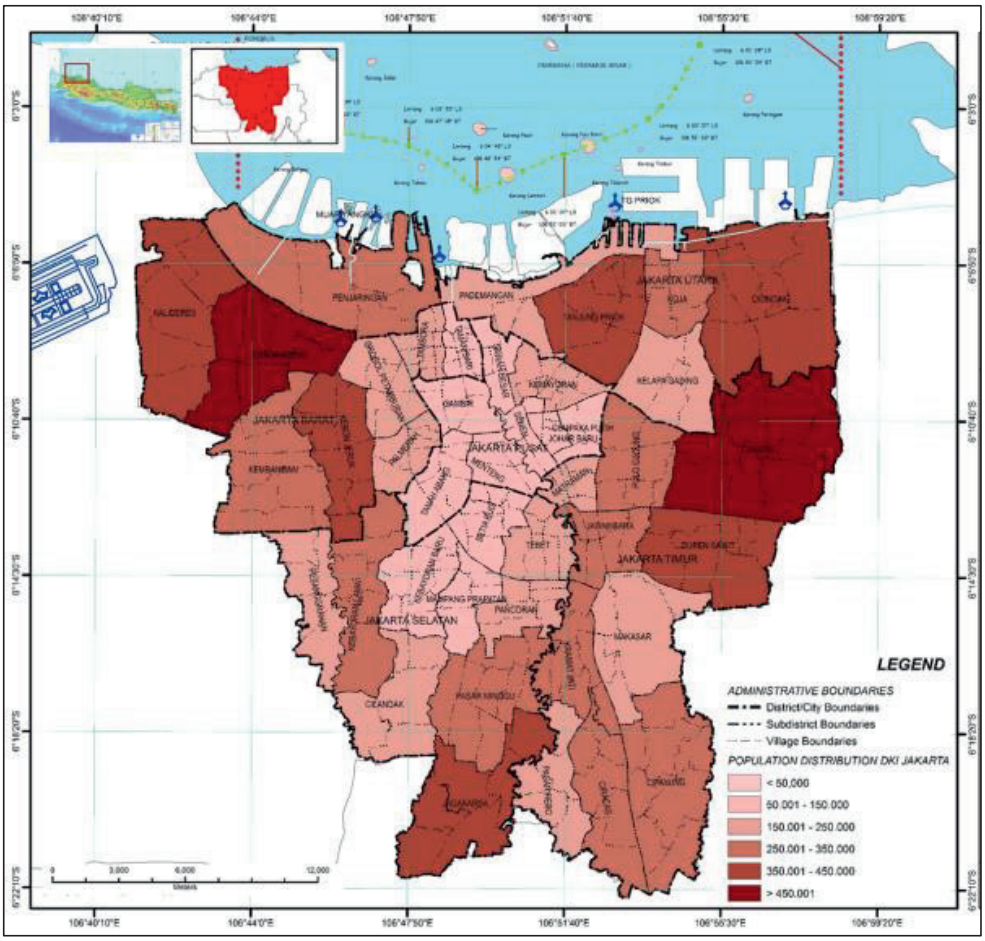


Figure 1.5 The population distribution of Jakarta year 2015 (Data from the Jakarta Statistical Office (2016); map courtesy of Adi Jaya Putra)

1.3 Research Questions, Overarching Goal, and Research Roadmap

This dissertation aims to capture the multifaceted features of the water supply in Bandung and Jakarta with its high share of informal provisions and heterogeneous behaviours, or as Furlong (2014) calls it: “the diverse realities of the South” (p.139). This is prompted by the statement of Mehta et al. (2007): “.. policy debates… often remain disconnected from the everyday experiences of poor and marginalised women and men… [and] are at odds with the framings held by local water users” (p.2). This research focuses on what’s “beyond access”, highlighting users’ perceptual drivers and everyday experiences in producing their drinking water supply, through individual strategies or collective endeavours, and their links to monitoring and policy. The central question of this research is: what are the various sides of access to water in the (peri)urban areas of Bandung and Jakarta? The overarching goal of this research is to gain a deeper understanding of the complex realities of water provision mechanisms in urban and peri-urban areas, by studying

individual household and collective strategies in securing access to a safer and more reliable water supply.

A series of questions are addressed in this research: What types of access do households have? What individual strategies are adopted by households? How do persistent individual household strategies relate to the dimensions of access? What are the drivers of bottled water consumption in Indonesia? How is access to water differentiated among households? How do differentiated access and individual household strategies affect water-related economic burden? How do communities collectively adopt strategies to cope with poor access and its dimensions? How do community strategies affect the dimensions of access? And finally, this research seeks to understand how these multifaceted realities –"beyond access"- fit in the water supply monitoring framework. These research questions are addressed in the subsequent chapters of this dissertation (Figure 1.6).

1.4 Research Perspective

This research is built based on a multidisciplinary perspective that includes environmental engineering, economics, psychology, and governance studies. Knowledge bases on water and sanitation technologies have been well established since the 1980s. The first international water and sanitation decade largely focused on hardware solutions and until now, the technocratic perspective is often seen as the universal fix for water problems (Mehta et al., 2007). To gain a deep understanding of the multifaceted access to water supply as the central issue of this research, a multidisciplinary view is imperative. As previously mentioned, the scope of multifaceted access to water includes physical access (along with its quality, quantity, continuity, affordability, and equity dimensions), the various health and economic impacts resulting from water supply provision (moderated by a series of user behaviours or strategies), and the diverse range of provision structures. Engineering and natural science approach the problem of solving water supply problems through the potential applications of diverse appropriate water and sanitation technologies, advanced water purification, and water quality and quantity assessment. In this research, this viewpoint is valuable in discussing the issue of various types of physical access to water, including the quality, quantity, and continuity dimensions of water supply. Studies that focus on the public health issues of the water problem traditionally link health issues to poor water supply service. This insight is needed in this research to understand the association of the health impacts of different types of access and behaviours towards water. Moreover, economists focus on topics such as cost-benefit analysis, choice and aversion behaviours modelling, and water tariffs assessment in assessing the water problem; the approach and principle of this discipline is essential in analysing water expenditure, affordability, and equity issues in this research. In addition, social psychology studies focus more on the motivation, perception, belief, and behaviour in the WASH sector. The socio-psychological perspective, along with the economic perspective, is crucial in understanding the choices and behaviours of the citizens, which are often not only based on economic rationales but also health and other motives. Meanwhile, scholars in the water governance body of knowledge emphasise the political and institutional aspects of water supply, which is important in analysing the structure of water supply provision.

1.5 Research Approach

Instead of being disentangled in the rigid dualism of the pure positivism and pure interpretivism schools of thought, this research embraces a pragmatic approach. This philosophical position recognizes the empirical and practical consequences of ideas, with the advantages of helping improve communication among scientists from different schools of thought in an attempt to advance knowledge and, more importantly, offer the best opportunities for deciding actions to understand complex real-world phenomena (Johnson & Onwuegbuzie, 2004).

The pragmatic approach considers both quantitative and qualitative methods as important and useful. This study therefore mixes quantitative statistical assessment and qualitative content analysis. In general, this research employs a concurrent, rather than sequential, design; this means that quantitative and qualitative methods are conducted in a parallel manner, although there are some previous qualitative findings that are fed into decision-making in the later quantitative parts of this research. This research also positions quantitative and qualitative methods as equal, rather than choosing one dominant approach (see Figure 1.7 for the mixed-method design matrix).

The quantitative parts of this study are carried out to: (1) illustrate the distribution pattern of access to water, water usage, water expenditure, and water affordability among households through descriptive statistics; (2) understand the factors that affect household water expenditure through multiple regression analysis; and (3) understand the effect of the change in the level of access towards water expenditure through quantitative scenario analysis. Meanwhile, qualitative inquiries also make up a major portion of this dissertation because the multi-disciplinary nature of the topics being studied that are too complex for numerical assessments alone. Content analysis is a research method for making replicable and valid inferences from data to their context with the purpose of providing knowledge, new insights, a representation of facts, and a practical guide to action (Krippendorff, 1980 in Elo & Kyngäs, 2008) that aims to build up a model, conceptual system, conceptual map, or categories. According to Elo & Kyngäs (2008), content analysis is a method of analysing written, verbal, or visual communication messages that systematically and objectively describes phenomena, which allows the researcher to test theoretical issues to enhance their understanding of the data.

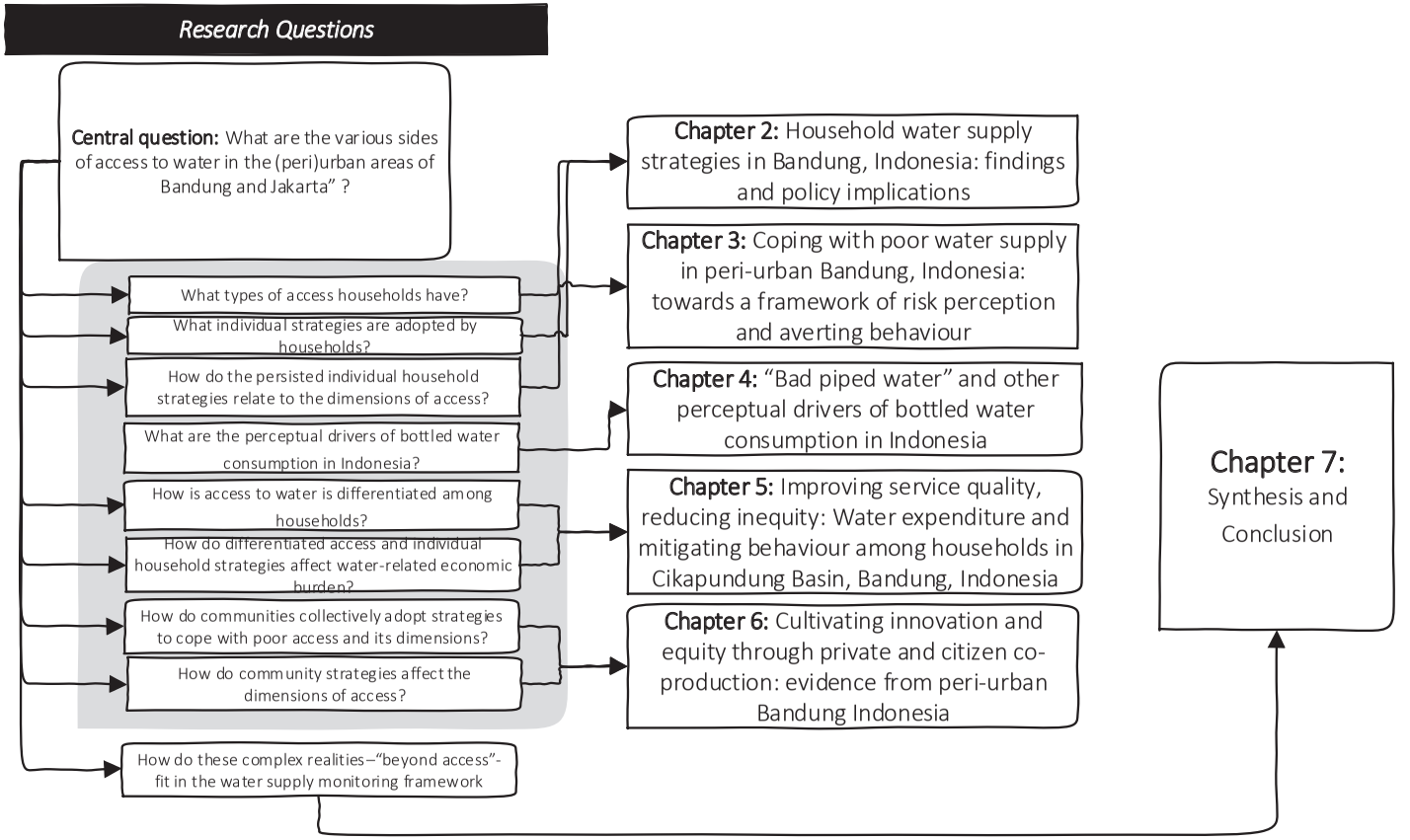


Figure 1.6 Research Roadmap

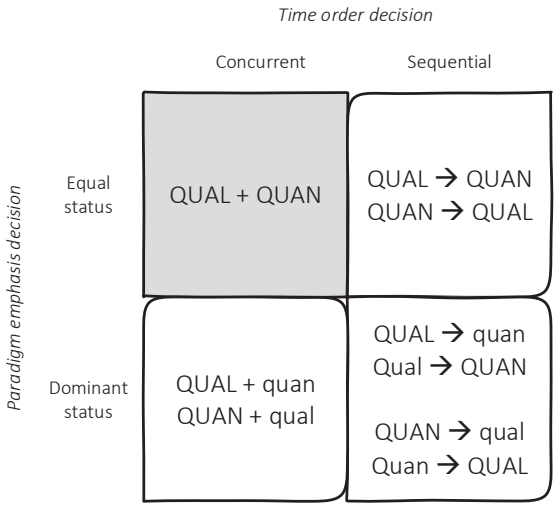


Figure 1.7 Mixed-method design matrix. "Qual" stands for qualitative, "Quan" stands for quantitative, "+" stands for concurrent, "→" stands for sequential, capital letters denote high priority or weight, and lower-case letters denote lower priority or weight (adapted from Johnson & Onwuegbuzie, 2004). The grey part is what is employed in this research.

In this method, words are distilled into fewer contents and those that share the same meaning are grouped into categories or 'codes'. The qualitative methods employed in this study aim to: (1) understand the various perceptual drivers of household and individual choices, behaviours, and water consumption; (2) develop a household behavioural framework in relation to the dimensions of access, risks, and risk beliefs; and (3) understand the institutional aspect of water provision.

Figure 1.8 shows the research design of this study. This research involves 1297 households in Bandung who participated in structured and semi-structured interviews; 287 branded bottled water consumers residing in Jakarta in Bandung who participated in an online survey; and 21 private, state, and community water actors related to local water supply provision in Bandung who participated in in-depth interviews. This research also examines 722 bottled advertisements that aired nationally since 2011.

1.6 Outline of the Dissertation

Chapter 1 provides an introductory context, specifically the concept of multifaceted access, overarching goal, research question, research paradigm, and brief methodological approach of this research.

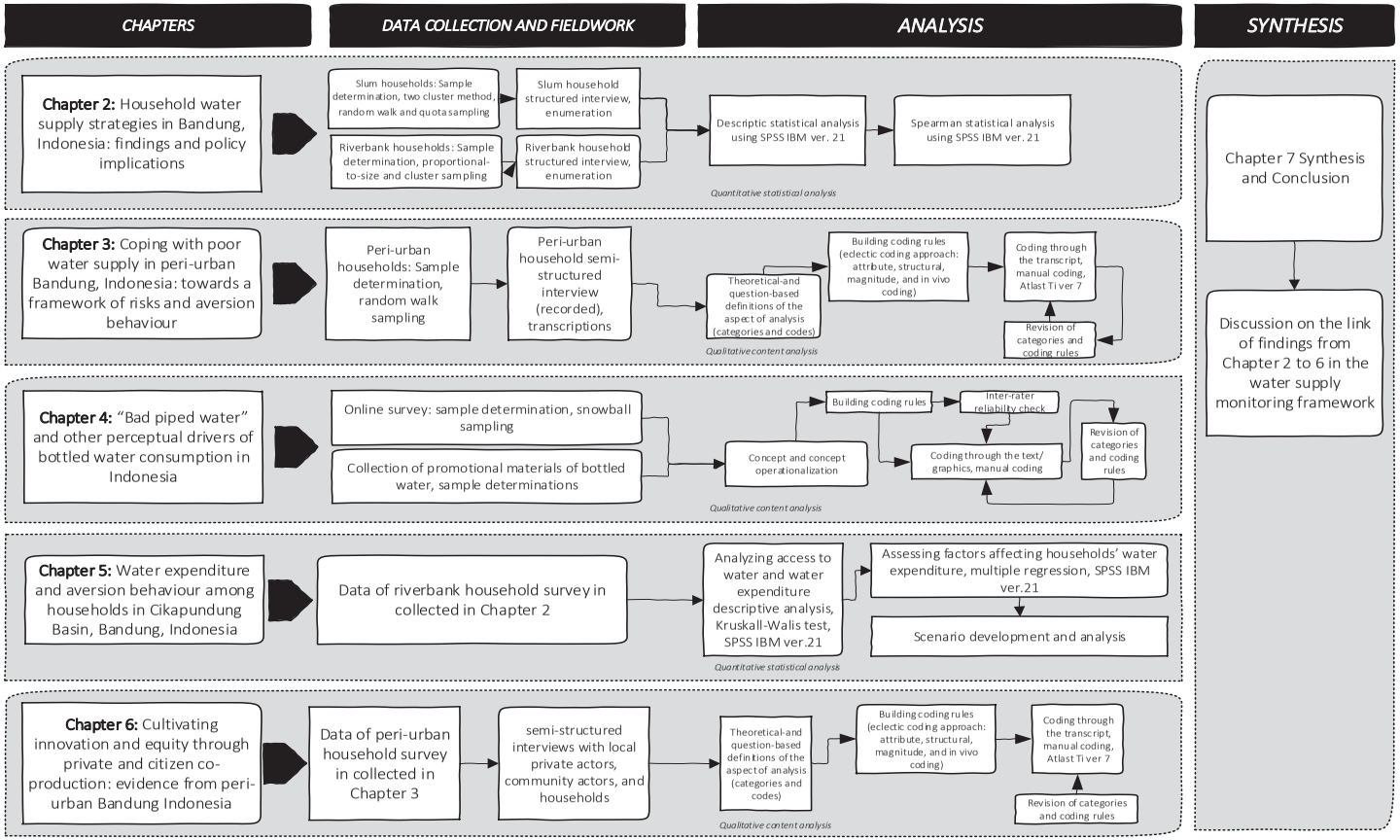


Figure 1.8 Research Design

Chapter 2 descriptively identifies the types of access, water usage patterns, and common strategies in vulnerable households. Three widely adopted water-related strategies among households in Bandung were identified: the use of multiple water sources, household storage, and household treatment. This chapter also explores the two sides of the coin in drinking water supply: access and its dimensions.

Chapter 3 explores the daily risks of households with respect to the dimensions of inadequate water access and supply (quality, quantity, continuity, and affordability). This chapter describes how perceptions of risk are shaped and how households seek to reduce the possible health impacts and potential economic losses through aversion behaviours. A framework that describes actual risk, risk perceptions, and aversion behaviours is developed. Risk perceptions and the adoption of aversion behaviours of varying frequency and intensity are based on a complex interaction between personal and shared experiences that relate to water supply dimensions, socioeconomic characteristics, and social networking.

Chapter 4 focuses on bottled water, the most popular drinking water source in Indonesia. This paper examines the perceptual drivers of the phenomenon of bottled water's rising popularity by looking at the perspective of consumers in Jakarta and Bandung as well as the perspectives of the top five bottled water producers. In countries that have established and have maintained a robust piped water system, bottled water has been perceived to be of better quality than piped water. It is argued that piped water and bottled water cannot be easily compared in the Indonesian context; drinking from tap water has never been accepted as the norm in Indonesia, as piped water has no guarantee of purity and safety. The substantial marketing efforts of the bottled water industry highlight the appeal of bottled water with regard to not only good water quality and physical health, but also taste, convenience, mental health, and social and environmental values.

Chapter 5 evaluates access to water, the direct costs, and the mitigation costs across households of different income groups in the Central Cikapundung Basin. Through scenario analysis, this chapter estimates the "hidden" mitigation costs of groundwater extraction and water boiling and highlights the importance of incorporating mitigation costs when assessing the economic impacts of poor water supply service quality in developing countries.

Chapter 6 shifts the focus of this research into the collective strategies adopted by peri-urban citizens under specific institutional arrangements. This chapter takes a closer look at the commercialized spring water provided by local entrepreneurs in peri-urban Bandung, Indonesia, as a means to deliver a clean water supply. Unlike other studies on co-production in the water supply sector, this study provides an exceptional example of private citizens' co-production in producing water service from commercialized springs.

Chapter 7 provides a synthesis of the research and interlinks findings from Chapter 2 to 6. This chapter particularly focuses on how these findings, with regard to multifaceted access, can inform water sector policy through monitoring. Finally, the general conclusions of this research are given.

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Chapter 2

Household Water Supply Strategies in Urban Bandung, Indonesia: Findings and Policy Implications

An earlier version of this chapter was presented at the 2nd International Conference on Sustainable Infrastructure and Built Environment (SIBE) in Bandung, Indonesia, 19-20 November 2013.

2.1 Abstract

Through structured interviews and statistical analyses, this study investigates access to water and strategies of 1227 vulnerable households in Bandung, Indonesia. The use of mixed water sources, household water treatment, and home storage suggest a low trust in improved sources and a compromised safety and reliability of water. While official statistics suggest a high level of access to 'improved' water sources, full-time access to such sources is overestimated. An integration of user behaviour into the new monitoring approach for water supply sector in the post-2015 development framework was proposed.

Keywords: *water supply; mixed water sources; household water treatment and storage; the Millennium Development Goals (MDGs); post-2015; monitoring*

2.2. Introduction

Using the indicator of access, one hundred and sixteen countries have achieved the Millennium Development Goals (MDGs)' drinking water target globally (WHO & UNICEF, 2014). There has been a wide concern that access does not always result into water safety and sustainability as mentioned in Target 7c of the MDGs. Although WHO & UNICEF (2013) recorded that 89% of the developing world's population have gained access to improved water sources, service quality problems have yet to be resolved.

Water supply is one of the main problems in urban areas. The size of urban population poses an enormous challenge to water provision through an increase in clean water demand. Ninety-six percent of urban populations have access to improved water sources (WHO & UNICEF, 2013), but the problems of poor water quality, interrupted service, insufficient disinfection, and infrastructure ageing and damage remain (Lee & Schwab, 2005). Urban dwellers are often forced to rely on more expensive water sources, such as bottled water, or more polluted sources. Setiono et al. (2012) suggest that half the urban households in Indonesia rely on groundwater without extraction fee, which may be polluted. Although about three-quarters of urban households use pour-flush toilets, very few households are connected to a safe disposal of their wastewater (Water and Sanitation Program, 2011). The high rate of enteric contamination of water sources reflects the poor sanitation facilities in Indonesia. For example, *E. coli* found in Jakarta's drinking water samples is mainly because wastewater discharges infiltrate the groundwater sources (Vollaard et al., 2004).

Urban water problems are partly driven by increasing demographic pressures, such as rural-urban migration and distorted rural-urban fringes. Indonesia has experienced a steady urbanization, which is projected to contribute 50 million urban inhabitants between 2014 and 2050 (United Nations, 2014). This growth is expected to be concentrated in cities such as Jakarta and Bandung (Mulatip & Brodjonegoro, 2004). With a total population of almost 2.5 million, Bandung City attracts tourists and job seekers alike; thus, the rapid population growth in Bandung is inevitable. A major improvement in water supply provision, for which the city government is responsible, must accompany this growth. Nevertheless, Yamani (2011) documented governance failures in drinking water service provision for the low-income community in urban Bandung. These failures are reflected by limited piped-water service availability; an inadequate quality, quantity, and continuity of water; a high cost burden to the poor; illegal connections; and a low trust in public service providers. The lack of reliable water services in Bandung leads to an excessive withdrawal of groundwater, which in turn threatens its sustainability and causes land subsidence problems (Abidin et al., 2008).

Using the case of Bandung, this chapter aims to understand the strategies of vulnerable urban households to secure access to a safe and adequate supply of water. This study also explores the two sides of a coin in drinking water supply: access and service quality. This study is descriptive in nature, and is one of only a few that have investigated user strategies and monitoring in depth. Howard et al. (2002) have discussed the implications of mixed water sources strategies and use differentiation for surveillance program. This study further discusses

recommendations to incorporate user strategies in securing access to safe water into the water supply monitoring approach of the post-2015 development framework.

2.3 Methods

This study focuses on two types of vulnerable population in Bandung City, West Java Province, Indonesia: slum and riverbank dwellers.

Slum Households. Slum areas are a national priority for the Acceleration Program of the National MDGs' Target Achievement (Ministry of National Development Planning, 2010). This study interviewed 127 out of 30,281 slum households that are distributed into five districts – Andir (n=23), Sumur Bandung (n=16), Rancasari (n=24), Bojongloa Kidul (n=27), and Cibeunying Kidul (n=37). Participants were selected through a representative and proportional-to-size sampling. The total number of slum households in Bandung City was obtained from the Information System and Database of Urban Slum Area of Directorate General of Public Works year 2009 (Directorate General of Human Settlements, 2009). The number of samples was determined based on Yamane's formula, a commonly used simplified approach in representative sampling, assuming 95% of confidence level with a 10% of margin of error (Kasiulevičius et al., 2006; Luanglath & Rewtrakunphaiboon, 2013; Yamane, 1967). A two-stage cluster method was also used to select samples (Lehtonen & Djerf, 2008). The first sampling unit are districts in which slum communities are located. These districts are listed in the Decree of Mayor of Bandung City year 2010 (Government of Bandung City, 2010). Slum neighbourhoods within each district were selected as the second sampling unit, in which households were chosen by random walk and quota sampling (United Nations, 2005).

Riverbank Households. The riverbank household survey was completed as part of the Drinking Water Safety Plan Pilot Project commenced by the Drinking Water and Sanitation Policy (WASPOLA) Facility and the Sanitation Working Group of Bandung City. WASPOLA Facility is an implementation project of community-based drinking water and sanitation policy and institutional-based drinking water and sanitation policy in Indonesia. Meanwhile, the Sanitation Working Group is an adhoc organization established as a communication and coordination forum among various governmental agencies in water and sanitation sector. This secondary data set was included in this study since riverbank dwellers represent both socio-economic and geographic vulnerabilities. Through a representative and proportional-to-size sampling, this study employed data from 1100 out of 11,471 riverbank households of the Cikapundung River. Samples were distributed into three primary target districts for the Water Safety Plan Pilot Project: Coblong (n=643), Bandung Wetan (n=267), and Cidadap (n=190). From each village within the districts, clusters of community groups were selected from the population registry of the Municipal Statistical Agency.

The slum household survey collected data on socio-economic status, basic health services, existing water and sanitation services, strategies for obtaining desired levels of service, as well as knowledge, attitudes, and practices concerning water, and self-reported illnesses. The riverbank household survey collected data on the socio-economic condition of households and access to and use of their water sources. The monthly income data in the slum household survey are based on

Minimum Regional Salary 2011 of Bandung City (Government of West Java, 2011). The Regional Minimum Salary is a minimum standard for industries to provide monthly salary to the unmarried labourers. It is proposed by a regional-level committee consists of representatives of bureaucrats, academician, labours, and industries; it may be revised each year and is stipulated through a provincial-level regulation. Meanwhile, the riverbank household survey did not use this classification. In both surveys, close-ended questionnaires were used, enumerators were carefully trained, and questions were asked verbally to respondents to avoid bias. The surveys were voluntary and did not contain information that would personally identify the respondents. Informed consent was given prior to the interview, and respondents who were willing to participate had the right to withdraw at any time during the interview. Data from the survey were statistically analysed with a descriptive method by using the IBM® SPSS Statistics Version 21.

2.4 Results

2.4.1 Household Vulnerability

Table 2.1 depicts the socio-economic profiles of households in this study. On average, two families of different generations share the same property in slum households. Meanwhile, the overall mean household size for the riverbank area is five persons. The majority of the head of households living in slum area are primary and secondary school graduates. Only small fractions of respondents and the heads of households pursued higher education levels. A low education level may affect socioeconomic status by reducing the opportunity for better income. Sixty-two percent of the heads of households attained secondary school or lower, and were reported to have a monthly income under the Minimum Regional Salary Year 2011.

Table 2.1 Socio-economic profile of respondents and households in slum areas (n=127) and riverbank areas (n=1100)

Component	Slum household		Riverbank household	
Average age of respondent	41 years old		45 years old	
Sex of respondent	Male	11.8%	Male	31.5%
	Female	88.2%	Female	68.5%
Marriage status of respondent	Married	87.4%	Married	91%
	Not married	3.1%	Not married	0.7%
	Divorced	1.6%	Divorced	8.3%
Position within the family	Head of household	17.3%	Head of household	33.3%
	Household member	82.7%	Household member	66.7%
Education of respondent	Unschooled	7.1%	Unschooled	3.7%
	Primary school	38.6%	Primary school	32.1%
	Secondary school	27.6%	Secondary school	21.6%
	High school	26%	High school	35.6%
	University/college	8%	University/college	7%
Occupation of respondent	Employee	1.6%	Employee	13%
	Entrepreneur/trader	26.8%	Entrepreneur/trader	21%
	Domestic worker/labour	2.4%	Domestic worker/labour	6%
	Retiree	1.6%	Retiree	3%
	Homemaker	60.6%	Homemaker	57%
	Others	7.1%	Others	0
Average number of (a) families in one house, and (b) person in one household	(a) 2 household (b) N/A		(a) N/A (b) 5 person	
Type of housing	Permanent	87.4%	Permanent	79.1%
	Semi/Non-permanent	12.6%	Semi/Non-permanent	20.9%
Housing ownership	Owned by respondent	72.4%	Owned by respondent	68.5%
	Not owned by respondent	27.6%	Not owned by espondent	31.5%
Monthly Household Income	< IDR 1,188,435 (≤ US$ 125)	53.5%	< IDR 1,000,000 (<US$104)	37.9%
	≥ IDR 1,188,435 or ≥US$ 125	46.5%	≥ IDR 1,000,000 (≥US$104)	62.1%
Most visited health facilities	Public health centre	59.1%	N/A	
	Private practice	22.8%		
	Clinic/hospitals	13.4%		
	Others	4.7%		
Source of health expenditure	Out-of-pocket expenditure	75.6%	N/A	
	Insurance/employer	24.4%		

Notes:

- Indonesia uses the term 'household' to represent a nuclear family registered in local registries.
- N/A means not asked in the questionnaire.
- Higher education attainment includes universities, academies, colleges, seminaries, and institutes of technology.
- IDR 1,188,435 is the Minimum Regional Salary for Bandung City in 2011 as stipulated in the Minimum Salary in the Regencies/Municipalities in West Java Year 2011.
- US$ 1= IDR 9,124 based on the Bank of Indonesia's conversion rate in November 2011. US$ 1= IDR 9,595 based on the Bank of Indonesia's conversion rate in December 2011.

Only 38% of the heads of households attained high school or higher education, and were reported to have a monthly income lower than the Minimum Regional Salary.

Access to healthcare services may also affect households' vulnerability. The survey revealed that 50% of slum respondents preferred public health clinics and 23% preferred private practices to seek healthcare services. Healthcare costs mainly drive the high preference towards public health clinics, as only 21% of the slum respondents are covered by health insurances. High out-of-pocket health expenditures, together with the lack of adequate water and sanitation service, will put households in a greater risk of health and economic impact. The majority of respondents were found to have a secure tenure and live in their own permanent houses. According to Local Government Asset Map (Municipal Planning Agency of Bandung City, 2010), the area selected in the slum household survey are not state-owned land. Meanwhile, only 0.9% of riverbank households interviewed had a vague status of ownership suggesting that they may live in state's land. Thus, water supply problems confronted by the majority of respondents is caused by poor service delivery rather than legal exclusion issues (Mudege & Zulu, 2011).

2.4.2 Household Strategies in Securing Access to Safe Water

2.4.2.1 The use of mixed water sources

Respondents use various piped and non-piped water sources. The types of water sources found in the slum area are piped water on premises, public tap, borehole, protected dug well, protected spring, water from vendors, and branded and non-branded bottled water. Non-branded bottled water produced in small refilling stations gain its popularity since the last decade in Indonesia, as a cheaper alternative to the more expensive branded bottled water. This refill water should also comply with the drinking water quality standard and water quality tests and sanitary inspections must be conducted to ensure the safety of refill water (Ministry of Health, 2002). Meanwhile, riverbank households use piped water on premises, public tap, wells (borehole/dug well), spring, bottled water, river water, and rain water. Figure 2.1 presents the levels of access to these water sources for each district in the slum and riverbank area.

Access to water in slum households was classified based on the three-step ladder of the Joint Monitoring Programme (JMP), which consist of piped water on premises, other improved sources, and unimproved sources (WHO & UNICEF, 2008). In the slum households, the level of access to piped water, other improved water sources, and unimproved water sources were 14%, 80%, and 6%, respectively.

Meanwhile, access to water in the riverbank households was classified as piped and non-piped sources. Out of 1100 riverbank households, piped water (45%) and groundwater (40%) were the most commonly used water sources. The fact that no riverbank household uses water from vendors does not represent a lesser preference for the source; householder stated that the topographical contour prevents water vendors from selling water in those areas.

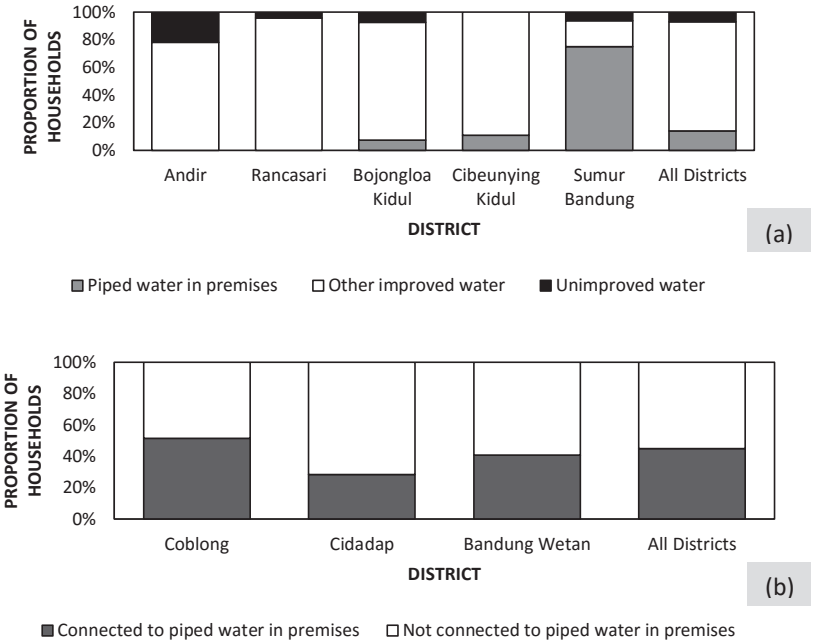


Figure 2.1 (a) Access to water based on the JMP's water ladder in the slum households in five subdistricts (n=127); (b) Access to water in the riverbank households based on piped/non-piped classification

In-house piped water connections supplied by the Municipal Water Company (MWC) of Bandung City are only available in three out of five districts of slum households. Piped water was largely present in Sumur Bandung and Cibeunying Kidul, which are located in the city centre, and relatively close to the MWC's main water treatment plant. From the 109 slum households that did not have access to piped water, 28% stated that they were interested in having a connection; meanwhile, 72% refused to have a connection, indicating a low trust in piped water providers. Meanwhile, access to piped water of the riverbank households was much higher than that of the slum households. The reasons may be two-fold: all the riverbank districts are located close to the MWC's main network, and more riverbank households may be able to afford a water connection compared to the slum households. The three riverbank districts surveyed are included in the MWC's service area, but access to piped water was less than 50%. Bandung City determines the target of minimum service standard of 120 litre per capita per day (Government of Bandung City, 2014). With the MWC's production capacity of 2,478 L per second and the city's standard minimum service of 120 L per capita per day, MWC can serve more than 72% of the population. However, only roughly, 30% of the total population of 2.5 million is served by piped water on premises.

As shown in Figure 2.1, slum households that solely rely on one or more unimproved water sources were counted as not having access. Ninety-four percent of slum respondents had access to one or more improved water sources. This number exceeds the national MDGs target for improved urban drinking water (7%) and it was

only six percent less than the 2019 universal access target formulated by the Government of Indonesia. Caution, however, has to be taken when using the access level estimate, which ignores the joint use of improved and unimproved sources by households.

In riverbank households, only 26% use a non-piped source, and 14% use piped water without mixing it with other water sources. In slum households, 66% of the respondents use mixed water sources. Respondents use piped water together with groundwater, public taps, or bottled water. Households without access to piped water rely heavily on boreholes and bottled water. Thus, although the level of access to improved water sources seems high, the overall percentage of households that uses unimproved water sources is 56%.

Figure 2.2 elaborates on the use of single and mixed water sources in slum and riverbank households, while Table 2.2 gives details on the combinations of different water sources. Figure 2.3 illustrates the specific use of each water source in the slum and riverbank households. The majority of households with access to piped water are willing to use the water for drinking and cooking. Meanwhile households with access to other improved water sources, such as boreholes and protected dug wells, are less inclined to use the water for such purposes.

Although the quantity and continuity of water from boreholes maybe quite reliable, the perception of poor water quality may discourage respondents to use groundwater for drinking. Respondents prefer bottled water despite its higher prices when compared to that of improved sources. A high preference of bottled water is observed in slum and riverbank households.

Bottled water markets are growing rapidly in urban Indonesia; one can find a range of products from the multi-national brands to the ones available in small refill water kiosks. The majority of slum respondents state that water quality is the main reason for using mixed water sources or unimproved water sources. For drinking purpose, they rely on bottled water that are considered safer. The trust in water quality and the ease of use perhaps explain the increasing popularity of bottled water among low-income households. However, branded bottled water is three to five times more expensive than refill bottled water, thus refill water kiosks are more commonly used by low income households.

A health concern may arise since health risks related to the consumption of refill bottled water are present. Many refill water kiosks are not certified by local health agencies, which means that inspections of water quality are rarely performed, if at all. Refill water kiosk owners may be negligence in term of best hygiene practices and not properly sterilize 19-litre water bottles prior to reuse. Studies have found that in many instances, refill bottled water in Indonesian cities is contaminated by coliform bacteria (Khoeriyah et al., 2013; Wandrivel et al., 2012). Thus, measures are necessary to ensure the safety of refill bottled water.

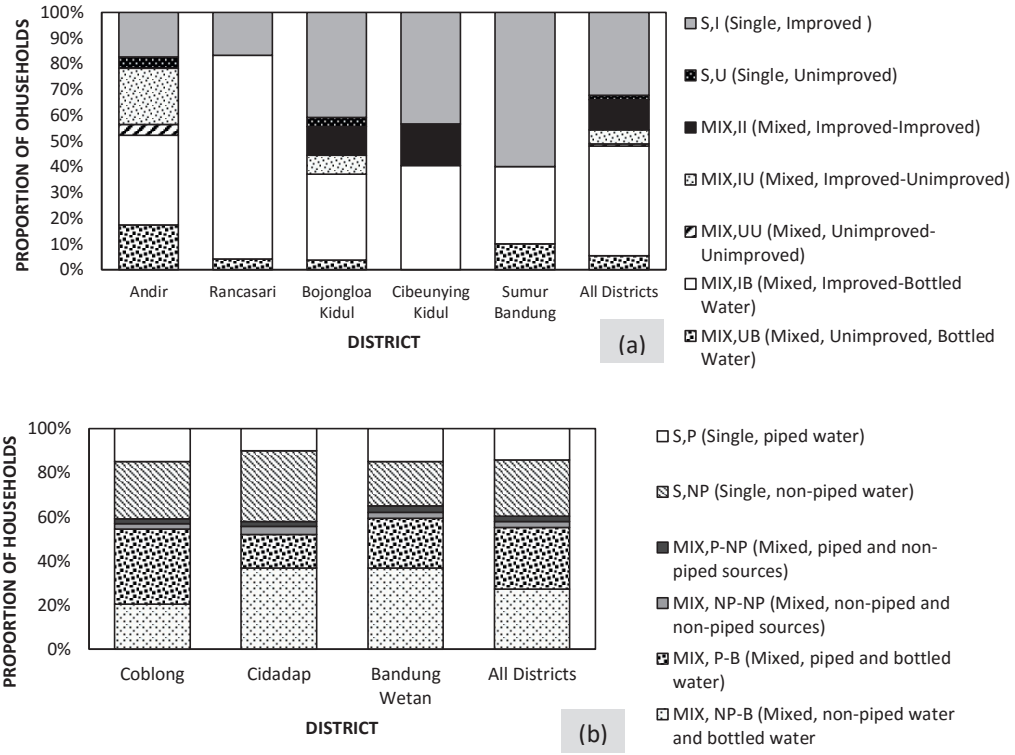


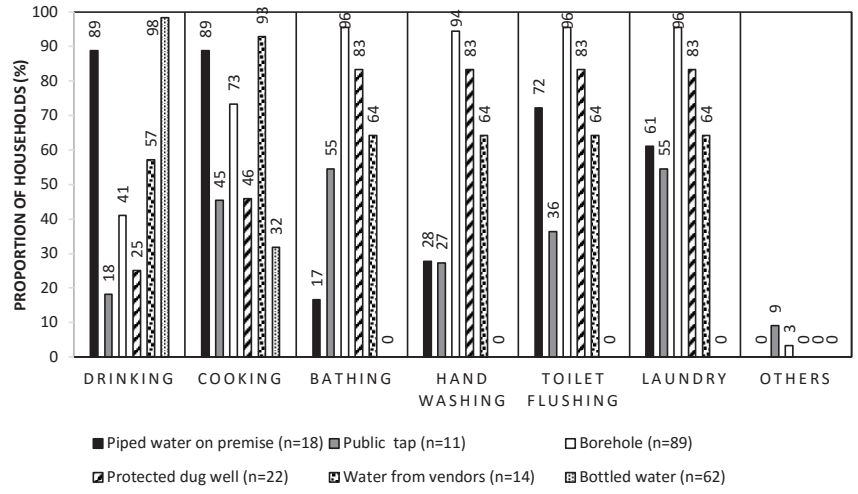
Figure 2.2 The use of mixed water sources within (a) the slum households (n=127); and (b) the riverbank households (n=1100). Piped water is classified as an 'improved source' for slum household survey

Table 2.2 The proportions of households combining different water sources in slum and riverbank area.

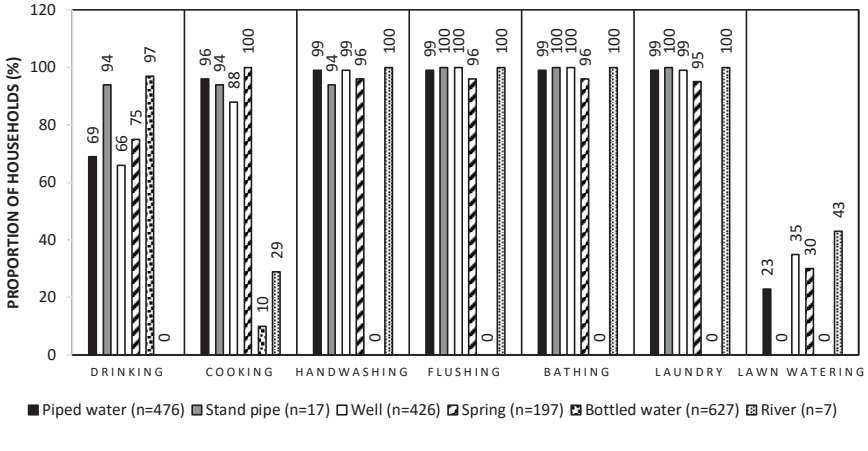
Water Source	Piped water (%)		Ground-water (%)		Spring (%)		Public Tap (%)		Pushcart Vendors (%)		Bottled water (%)		Others (%)	
	S	RB	S	RB	S	RB	S	RB	S	RB	S	RB	S	RB
Piped water	-	-	33	7	6	2	33	7	0	-	11	62	0	0
Spring	100	4	0	15	-	-	0	0	0	-	0	45	0	2
Ground-water	5	8	4	-	1	7	2	0	8	-	50	54	1	2

Notes:

- RB (riverbank households): $n_{piped\ water}$ = 495, n_{spring} = 212, $n_{groundwater}$ = 438.
- S (slum household): n_{piped} water =18, n_{spring} = 1, $n_{groundwater}$ = 112.
- "Groundwater" in slum households includes shallow wells and boreholes. Some households combine both sources for daily uses.
- Water vendors using pushcarts do not operate in riverbank area due to its difficult terrain.



(a)



(b)

Figure 2.3 Specific water uses by households in (a) the slum households and (b) the riverbank households (Note: n represents number of households having access to each water source; one household can have access to more than one source of water)

2.4.2.2 Household water treatment and storage

Despite a high level of access to improved sources in slum households, water quality from these sources remains a question. Figure 2.4 shows household water treatment strategies performed by the slum dwellers to obtain the desired level of quality. More than 60% of piped water users and 50% of those having access to other improved water sources perform household water treatment measures. Meanwhile, the proportion of unimproved water users that perform household water treatment is low, probably because bottled water is the most commonly used type of drinking water source.

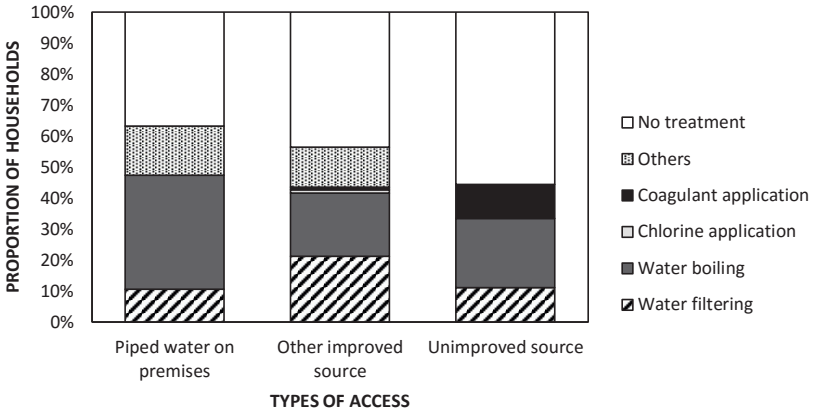


Figure 2.4 Household water treatment in the slum households based on the JMP's water ladder

Water boiling is the most preferred method of disinfection amongst the slum households, particularly amongst piped water users. The efficacy of boiling has been investigated; households that do not boil water have a higher water contamination risk compared to those who do (Sodha et al., 2011). Householders are not familiar with disinfection properties of chlorine; only 54% of respondents state that chlorine can kill pathogens in water. The attitude of respondents toward various household water treatments also confirmed these findings. More than 90% of the respondents agree that boiling water can improve water quality, and only half the respondents agree that water quality improvement could also be achieved through water filtration, the use of coagulants, or chlorine application. Although the rise of fuel prices makes boiling water more costly compared to other treatment methods, these hidden costs are neglected. The installation of water filters is perceived to require a high capital cost, and is commonly used by middle-to-high-income borehole users.

Slum respondents also perform the water storage strategy. Sixty-six percent of slum households prefer to store water because of continuity issues. Figure 2.5 shows water continuity in slum households during dry season. Only less than 30% of piped water users experience a reliable service for 24 hours a day; the remaining 70% of piped water users only have access for four to twelve hours per day. The continuity issue is also applied for unimproved water sources if water vendors are the main supplier of water. However, household water storage can also pose potential water-related health risks if it is not safely performed. The knowledge, attitude, and practice survey revealed that the majority of respondents are aware of the water contamination risk associated with storing water in open containers. More than 90% of slum respondents are aware that open water storage carries the risk of contact with rats and provides a breeding place for disease vectors. All bacterial contaminations of drinking water occur as a post-source contamination instigated during storage in households (Subbaraman et al., 2013). In spite of these contamination risks, as many as 40% of the households continue to use open containers for storing water at home. Safe storage and household water treatment interventions may improve water quality in slum areas (Subbaraman et al., 2013). Thus, guidelines for household water treatment and safe storage, as prominent

practices in slum areas, should be disseminated. Even so, this attempt does not replace the main responsibility of providing water supply facilities that provide safe and reliable supply of water.

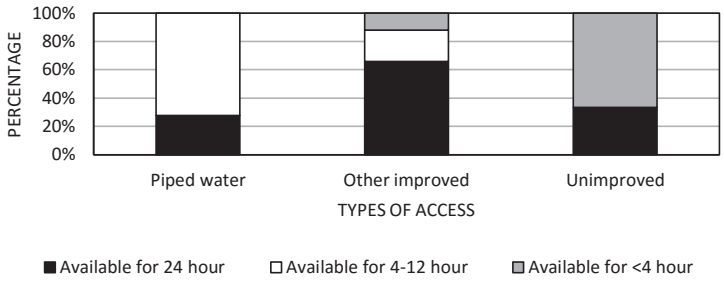


Figure 2.5 Continuity of drinking water sources in the slum households during dry season

2.4.2.3 Potential health impacts of water, household strategies, and safe sewage disposal

In the slum household survey, Spearman's statistical analysis was performed to determine the correlation between the type of access to water (piped water, improved, and unimproved) and the reported illnesses. There is no significant association between the types of access available with the self-reported diarrhoea incidences (rs = -0.0.53) and self-reported skin diseases (rs = -0.056). The similar test was also applied to Cikapundung households. Spearman's statistical analysis was performed to determine the correlation between the type of access to water (piped water and non-piped water sources) and the reported illnesses. There is no significant association between the types of access available on premises with the self-reported diarrhoea incidences (rs = 0.097) and self-reported skin diseases (rs = -0.004).

Figure 2.6 explores the links of diarrhoea, access to water and household treatment. The rate of self-reported diarrhoea was calculated as the number of participants reporting diarrhoea divided by the total number of participants in the category (Neumann et al., 2014). The rate of self-reported diarrhoea is the lowest for households with the highest level of household treatment. In contrary, households with less level of home treatment adoption, although using more than one improved water sources, have a higher rate of self-reported diarrhoea. Bottled water users have a lower rate of self-reported diarrhoea compared to non-bottled water users who perform low level of household water treatment. The health risk in these households was probably prevented by the use of bottled water with a more trusted quality compared to other sources used without treatment. Even so, as previously discussed, the risk for consuming loosely regulated refill bottled water cannot be neglected.

Slum respondents were also asked if they were connected to a safe sewage disposal facility. Cross-contamination of water sources and wastewater in 37.8% of households was prevented through pit latrine (1%), municipal sewage treatment facility (4%), and communal or individual septic tank (33%). Meanwhile, 58% of slum

respondents had no connection to a sewerage system or on-site wastewater treatment facilities, such as safe latrine and septic tank. Furthermore, open defecation practice was still performed in Rancasari District. Figure 2.6 also suggests faecal materials are dumped daily into receiving water bodies. Although this study did not cover water quality analysis, it expected that inadequate sanitation facilities pose contamination risk of groundwater, which is used as the main water source by the majority of households in Bandung.

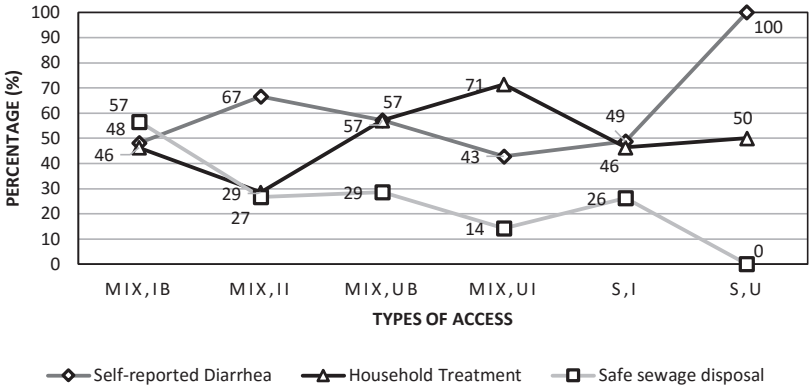


Figure 2.6 The rate of self-reported diarrhoea, the percentage of households performing home water treatment, and the percentage of households with safe sewage disposal in slum households based on type of access (MIX,IB: mixed sources, improved-bottled water; MIX, II: mixed sources, improved-improved; MIX,UB: mixed sources, unimproved-bottled water; MIX,UI: mixed sources, improved-unimproved, S,I: single source, improved; S,U: single source, unimproved water). Piped water is classified as an improved source

Figure 2.6 shows that almost all households with different types of access to water have less than 50% coverage of safe sewage disposal. The rate of self-reported diarrhoea seems to be lower in households with higher level of water treatment, although the coverage to a safe sewage disposal facility is low. The effect of poor sanitation on health may be negated by the use of bottled water and household water treatment strategies.

2.5 Discussion

2.5.1 Challenges to improve access and service quality

The previous sections have demonstrated the coping strategies of vulnerable urban households and the potential health impact resulting from combinations of access and strategies. The findings on different household strategies to obtain a safe and reliable supply of water confirm what Howard et al. (2002), Neumann et al. (2014), Pattanayak et al. (2005), Spencer (2008), Zérah (2000) had studied.

Despite high access to the so-called improved water sources, vulnerable households are struggling to resolve the problems of poor service quality where the safety and reliability of household water sources are still compromised. Many of the vulnerable households cannot access an uninterrupted piped water supply— that has undergone a full range of treatment to eliminate microbial, physical, and chemical agents. When piped water supply was available, most households refused to directly drink the water without boiling it first. Some also decided to rely on bottled water for drinking. This behaviour signals the lack of trust in water quality and the concern of re-contamination in the deteriorating distribution networks. Studies confirmed that bottled water is often preferred over tap water and perceptions of water quality drive the drinking preference of consumers (Gorelick, et al., 2011; Huerta-Saenz et al., 2012).

"Despite high access to the so-called improved water sources, vulnerable households are struggling to resolve the problems of poor service quality where the safety and reliability of household water sources are still compromised."

Slum household surveys also revealed that households receiving water from unimproved sources are the households least likely to engage in point-of-use household water treatments. This may be explained by the high use of bottled water as a form of unimproved sources among households. Note that bottled water is considered "improved" only if water for other domestic purpose originates from some kind of improved sources. As the most preferable choice of drinking water, refill bottled water has obtained a high trust among its customer, quality-wise. Nevertheless, the emerging numbers of unregistered refilling stations can pose a significant threat to consumers' health if regulators fail to ensure they meet the safety standard for drinking water.

The low association between the rate of self-reported diarrhoea and the types of access to water based on improved/unimproved classification support what Shaheed et al. (2014) argue: that improved water sources are not necessarily safe. The authors further suggest that microbiological risks among households with access to improved water sources are contributed by water storage, risk specific to water supplies, and household water management practices. This study found that households refuse to drink 'uncooked' piped water due to the poor perception of water quality, invest in several means of household water treatment, and sustain open container storage practices. These behaviours suggest that the risks of contamination at the point-of-use exist.

The binary water problems revealed in this study are in line with what Rouse (2014) argues: that to achieve universal access to water, expansions of new infrastructure to keep up with urban growth as well as renovations of the existing infrastructure to maintain the desired level of access are crucial. As Rouse (2013) mentioned, a

significant investment in the piped water networks is required to avoid increasing the loss of access to acceptable service. A high percentage of piped water users prefer alternative drinking water sources or invested in household treatment strategies. Thus, piped water suppliers are suggested to improve treatment efficacy and the protection in distribution network. Effective resource allocation, to not only build new connections, but also to repair and maintain the existing ones, is needed.

2.5.2 Implications for Policy and Monitoring

2.5.2.1 The use of mixed water sources and the Domestic Water Mix Optimization (DWMO) Policy

The use of mixed water sources among slum households, particularly the combinations of improved and unimproved water sources, suggests that the actual percentage of households accessing improved water sources on full-time bases is overestimated. The use of mixed water sources has been a common practice in Indonesia, particularly in Bandung. Nevertheless, policy documents did not officially recognize this practice until the WASPOLA Facility proposed the Domestic Water Mix Optimization (DWMO) policy (Government of Republic of Indonesia, 2015). With the principle of 'every drop of water counts' as its core, this strategy strives to improve efficiency and effectiveness of domestic water provision through an optimization of various types of water sources, demand management, and water quality for specific uses. DWMO groups domestic water into four classes of use: human consumption, hygiene, toilet flushing, and outdoor use. These uses have different water quality requirements. As Spencer (2008) argues, it does not make any sense to use drinkable water for toilet flushing. Although the DWMO policy will be extremely useful in rural or low-density area in which centralized water supply may be less effective, the DWMO must be carried out with discretion in urban area. The DWMO will not provide an argument to shift from networked service expansion.

Having been piloted in Bandung, this strategy, which was mainstreamed into the 2015-2019 Indonesian Midterm National Development Plan, is still in its infancy. Lately, the WASPOLA Facility has developed a tool for local governments in selecting the most efficient household water sources. An earlier recommendation from WASPOLA to the DWMO scheme was to discourage the use of bottled water since it produces a high cost burden to poor households. The high dependency on such an unsustainable drinking water source signals the failure of water supply provision. Moreover, the DWMO scheme highly depends on the attitude and perception of what is considered 'safe water', which may be viewed differently by policy makers and users. For example, the high trust to refill water is often misplaced since the safety of such water sources is weakly enforced. Therefore, analyses on water use behaviour and household water treatment and storage will provide a useful entry in designing the DWMO's locality-based scheme.

2.5.2.2 Implications for Monitoring

The national estimates of the coverage of "improved water supply" coverage are based on aggregated data from the National Socioeconomic Survey (SUSENAS), a wide-ranging demographic survey conducted periodically. These survey-based data often do not apply to different local settings. For example, in the latest Mid-term Development Plan, there is no term "improved water sources" to indicate the coverage of improved water sources (Government of Bandung City, 2014). Moreover, the emphasis on access tends to ignore the mixed water source strategies and misrepresents the real types of access in complex urban settings.

The National Statistical Office changed the way water supply is classified. Before 2011, households were classified as 'improved' if their main drinking water sources originated from improved sources. Since 2011, households are classified as 'improved' if water sources used for bathing/washing activities originated from improved sources. This shift caused a seemingly increasing trend in coverage for improved water supply (see Figure 2.7). The Ministry of the National Development Planning (BAPPENAS), in the National Report on MDGs Progress, also included households using bottled water combined with improved water in their estimate. The number of households with access to improved water was revised in the Report: from 43% to 55% (Ministry of National Development Planning, 2012).

Likewise, there is a grey area between piped water and water from vendors; most vendors obtain water from water taps and then carry it to the areas beyond the piped network (Setiono et al., 2012). This issue had been accommodated by SUSENAS; since 2007, SUSENAS module has differentiated households using individual connection of piped water and those who buy piped water from vendors in retail and caused a significant decrease in access to piped water from 2008 onward (see Figure 2.7).

This study also provides evidence for the challenges of the JMP's approach in monitoring: the current set of indicators does not address the safety and sustainability of water supply sources ((WHO & UNICEF, 2012). Although the JMP classifies bottled water as 'improved' if water used for other hygienic purposes originates from improved sources, it is important to differentiate households using bottled water to point out the trend that bottled water use increases, while exclusive access to piped water decreases. The results of this research can be used to improve accountability and to target improvement in terms of access and service quality for both piped water providers and non-piped water system managers.

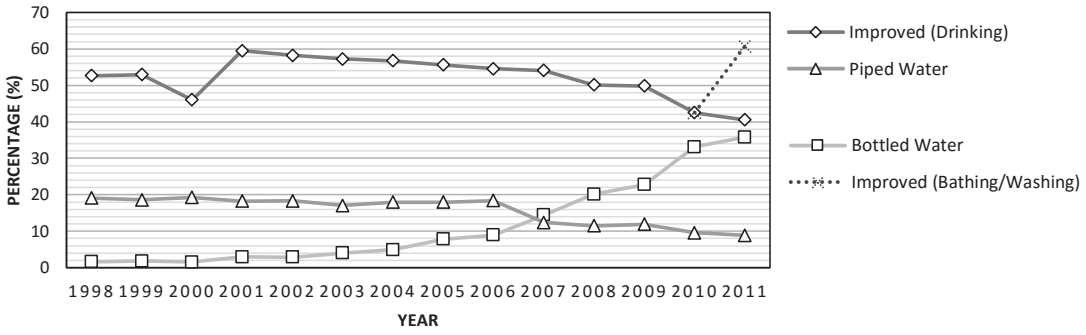


Figure 2.7 The trend on access to improved sources, bottled water, and piped water in urban Indonesia from 1998 to 2011. The National Statistical Office of Indonesia, had separated households with access to piped water bought from vendors since 2007. This causes a significant decrease in the level of access to piped water. In 2011, the National Statistical Office reclassified household as having access to 'improved sources' if, within a household, bathing and washing activities are satisfied through one or more improved water sources (data was taken from SUSENAS, the annual socioeconomic survey undertaken by the National Statistical Office, courtesy to Ahmad Komarulzaman)

In the post-2015 development framework, there will be sufficient space for national policy design and adaptation to local settings to avoid a one-size-fits-all solution while continuing to respect international standards. Different national circumstances, capacities, and priorities will be taken into account (United Nations, 2012). Contextually, the twofold water problems in Indonesian cities as well as the newly developed DWMO strategy require a new perspective for monitoring. Even though a future monitoring framework means taking into account the aspect of water quality, it is expensive to carry out a nation-wide household water quality analysis in Indonesia. At present, SUSENAS module for drinking water supply focuses on the source of drinking water, the type of access (shared/individual), distance from ground water sources (i.e. borehole, well, or spring) to sanitation facility, and the means to obtain access (buying/not buying). Moreover, there is no robust monitoring in place to ensure water safety aspect. The various strategies adopted by vulnerable households demonstrate that when a centralized drinking water is inadequate, the responsibility for obtaining access to water and securing the safety of drinking water falls to the consumer by default (Mintz et al., 2001). To accommodate the service quality aspect of urban water systems, the existing statistical approach can be improved by adding a layer of complexity to the dimensions of access: the particular domestic water mix that represents the multiple access routes to various water sources and their specific uses. This will be especially useful in providing evidence for the DWMO policy and for designing effective interventions in addressing Indonesian urban water problems.

"…when a centralized drinking water is inadequate, the responsibility for obtaining access to water and securing the safety of drinking water falls to the consumer by default"

2.5.3 Survey Limitation

One limitation of this study is the random walk and quota sampling strategy for slum household survey that may cause biased household samples, as respondents who are more likely to be available and eager to participate are selected.

2.6 Conclusion

Where public-provided water is scarce, informal practices thrive; these are complex in nature and are often unaccounted for in the formal monitoring and measuring of sector performance. The sustained use of mixed water sources is a noted example. Shall households that have access to both piped connection and water from vendors, yet rely heavily on the latter due to interrupted supply of piped service, be considered as improved or unimproved? How can performance reports capture these mixed water sources strategies? This study may contribute to the literature by further acknowledging local complexities on the characteristics of water supply service. The results also have a significant implication for monitoring, mainly since commercial water has a significant increased popularity among households.

Although the JMP classified household using bottled water as improved if the source for cooking and personal hygiene is improved, the high use of bottled water among improved water users should not be neglected since it suggests a low trust in public-provided water. The reluctance of households to connect to piped water also calls for a major improvement to the accountability of municipal water supplier in improving its service quality. As Zérah, (2000) suggests "…it appears clearly that the notion of access to water does not really exist" (p. 297). Innovative approaches in measuring water supply performance are needed to ensure that the service reaches those who need it the most. This will be particularly noteworthy when developing water service for vulnerable populations in urban areas within the framework of the post-2015 water agenda. Finally, qualitative studies on households' choices to water sources are needed to better understand differentiated access to water in developing countries.

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Chapter 3

Coping with poor water supply in peri-urban Bandung, Indonesia: towards a framework for understanding risks and aversion behaviours

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3.1 Abstract

This paper explores the daily risks of households with respect to dimensions of inadequate water access and supply (quality, quantity, continuity and affordability). We describe how perceptions of risk are shaped and how households seek to reduce possible health impacts and potential economic losses through aversion behaviours. To this end, households' activities relating to water storage, treatment and usage, together with water source preference, were analysed using a qualitative approach. We developed a framework that describes actual risk, risk perceptions and aversion behaviours. Risk perceptions and the adoption of aversion behaviours of varying frequency and intensity are based on a complex interaction between personal and shared experiences that relate to water supply dimensions, socioeconomic characteristics, and social networking. Moreover, we discuss household risk management strategies and provide some recommendations aimed at improving future approaches to the study of aversion behaviours.

Keywords: *affordability, aversion behaviours, Bandung, continuity, dimensions of access, quality, quantity, risk, water supply*

3.2. Introduction

How do risk beliefs and perceptions relating to the possibility of loss and damage emerge? [i] How do people operationalize these on a daily basis? This paper attempts to answer these questions by examining how households seek to cope with poor water supply. Inadequate water supply remains one of the foremost problems in many low- and lower-middle income countries. Measures of water supply adequacy are comprised of the different aspects of water provision: physical access, quality, quantity, continuity and affordability. Drinking water should be provided in close proximity to dwellings, thus preventing excessive collection time. Water must be free from contaminants posing health risk to a person. Water should be adequate and continuous for drinking and maintaining hygiene. Lastly, costs related to water should not prevent a person from accessing safe drinking water and should not restrict him or her from enjoying other basic rights (United Nations, 2007a). These are called "the dimensions of access" (Nganyanyuka et al., 2014). The lack of access to an adequate water supply for basic needs, along any of these dimensions, exposes households to risks of preventable illness and impoverishment (Rijsberman, 2006).

Drinking water should be provided in close proximity to dwellings, thus preventing excessive collection time. Water must be free from contaminants posing health risk to a person. Water should be adequate and continuous for drinking and maintaining hygiene. Costs related to water should not prevent a person from accessing safe drinking water and should not restrict him or her from enjoying other basic rights

Drinking water supply in low- and lower-middle income countries frequently does not meet the requirements of physical access, quality, quantity, continuity and affordability (see Bain et al., 2014; Kumpel & Nelson, 2013; Banerjee et al., 2008; Kayaga & Franceys, 2007; Vollaard et al., 2005). The lack (or absence) of an adequate centralized water supply inevitably shifts the responsibility for obtaining a safe and reliable supply to households (Mintz et al., 2001). Inadequacies relating to the dimensions of access may lead to a variety of strategies employed by households (Zérah, 2000; Pattanayak et al., 2005; Howard et al., 2002). Boiling, filtration, chlorine application, and ultraviolet (UV) disinfection are considered appropriate treatment methods for improving water quality (WHO & UNICEF, 2011). The storage of water within households is also a common practice when water is not directly delivered or if water flow is not guaranteed (Bartlett, 2003). The unreliable provision of piped water can also force households to construct capital-intensive storage tanks that provide reserves of tap water or rainwater (Adekalu et al., 2002). When no other option is available, buying water from small-scale enterprises becomes a last resort for those desperately in need of a clean water supply (Njiru & Albu, 2004). This is evident in data from low- to middle-income countries. For example, in Indonesia, 40 per cent of urban dwellers buy water (National Statistical Agency, 2015).

The relationships between inadequacy relating to the dimensions of access and household strategies are often presented in the literature as "aversion behaviours" (Abrahams et al., 2000; Jakus et al., 2009; Janmaat, 2007; Nauges & van den Berg, 2009).[ii] Although research has established a clear relationship between aversion behaviours and perceived health risk, how households decide among different aversion behaviours is understudied. Studies that link aversion behaviours with other dimensions of access (physical access, quantity, continuity, and affordability) are

also limited.[iii] Um et al. (2002) have described how aversion to unsafe drinking water emerges at the end of a generic process that is comprised of three steps: 1) Households are exposed to a water supply that is perceived to contain a high level of contaminants that may endanger health; 2) Household perceptions lead to non-action or to a selection of actions that may reduce the perceived risks; 3) Households decide on the level of action required to obtain an acceptable level of risk.

One study examining the risk of arsenic exposure concluded that risk beliefs are socially constructed, as a result of everyday interactions, personal experience, local knowledge, and social networking (Chappells et al., 2015). However, similar studies on a broader scope of dimensions of access are scarce. It remains unclear exactly how perceptions emerge, and how (and why) these perceptions result in decisions that lead to particular behaviours to avert risk and loss.

This study aims to define how households perceive and seek to reduce risks through aversion behaviours in response to poor water supply in a peri-urban area of Bandung City, Indonesia. We employed a qualitative analysis approach by examining in depth how households choose between different aversion behaviours in response to poor dimensions of access to water.

Next, we provide background information on the study area, Ujungberung District. We then explain the methods used in the study, describe the households interviewed, and elaborate the water sources available to those households. We consequently present the results of our analysis of aversion behaviours, followed by a framework describing the relationship among dimensions of access, actual and perceived risks, and aversion behaviours. Finally, we conclude that risk perceptions and decisions relating to the adoption of certain aversion behaviours result from a complex interaction of the different dimensions of access to water, personal and shared experiences, socioeconomic attributes, and social networking. We also provide recommendations aimed at improving future approaches to the study of aversion behaviours and household risk management.

3.3 Ujungberung District

Our study focuses on households in Ujungberung District, part of Bandung City, Indonesia (Figure 3.1). This district,[iv] established as a result of a 1987 reclassification of the city borders of Bandung City,[v] is inhabited by 18,467 households and has a population density of 11,742 people per km^2 (Statistical Agency of Bandung City, 2015b). The National Statistical Office classifies the entire district as “urban”(National Statistical Office, 2010) However, Ujungberung District is situated at the outer northeast limit of the city, adjacent to a district that has a more rural character.

Ujungberung District was selected for the study owing to the wide variety of water sources available to it: metered piped water, deep groundwater, shallow groundwater, spring water, river water, and various forms of commercial water (e.g. bottled water, water from vendors). Piped water comes from a mini-plant (MP) Cipanjalu,[vi] operated by the Municipal Water Company (MWC). MP Cipanjalu only serves 1,231 households, or 6.7 per cent of the total district population (Bandung City, 2014). It employs a conventional treatment process and distributes water via in-

house connections. Ujungberung District features several river tributaries, but these are rarely used as a source of water for direct human consumption.

One of the main rivers in the district, Cipanjalu, provides raw water for MP Cipanjalu. Importantly, Ujungberung District is not connected to the municipal sewerage system and centralized wastewater treatment facilities. Faecal sludge is directed to the river or to individual or shared septic tanks that function as storage and containment facilities. These septic tanks often do without appropriate infiltration areas and regular maintenance. Meanwhile, greywater is directed to the main stormwater channels in the district and flows to receiving rivers without treatment. Poor sanitation causes water contamination risks in the district.

Bandung City features a highly productive aquifer, but has suffered from a continuously decreasing groundwater level since 1995 (Harnandi et al., 1997). Seventy-seven per cent of the Ujungberung District population use groundwater daily by accessing shallow wells and deep boreholes equipped with electrical pumps (Bandung City Health Office, 2013). Meanwhile, the geographical position of Ujungberung District at the foot of Mount Manglayang creates ideal conditions for natural springs that supply inhabitants with an abundance of spring water. The commercialization of spring water in the early 2000s increased the accessibility of clean water, which is supplied through individual, shared or communal provision, and vending. Thus, spring water in the local area has a high market penetration.

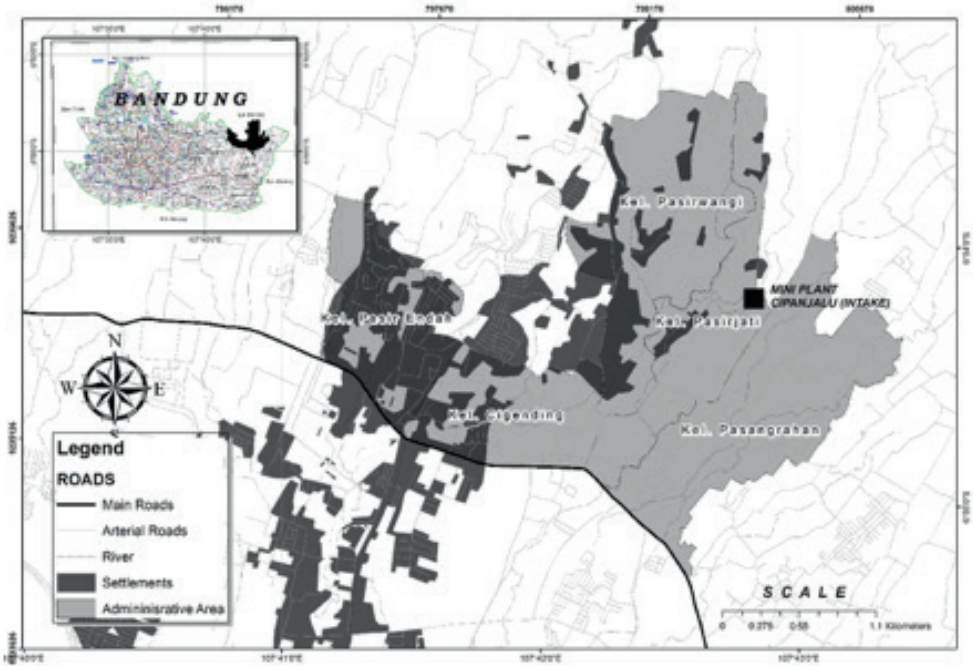

Figure 3.1 Ujungberung District (Map courtesy of Ade Rahmat).

3.4 Methods

We carried out a survey of 70 households in Ujungberung District, Bandung City, with participants selected through a convenience sampling approach (Isaac & Michael, 1995).[vii] Despite the known limitations of this approach, we confirmed that the sample represented the use of all identified water sources in the area. We used a questionnaire that was comprised of closed- and open-ended questions. The closed-ended questions were designed to obtain data on the characteristics of respondents, their access to water, water use, and sanitation. IBM® SPSS version 21 was applied in a descriptive analysis of this data.

The open-ended questions explored key themes relating to how participants perceived risks and chose between different water sources and different water-related strategies (see Appendix 3.1). We focused on the application of three water-related strategies that were widely adopted among households: household storage, household treatment, and the use of multiple water sources.[viii] Additionally, we examined households' rejection or acceptance of public piped water supply.

Respondents' answers were taped and transcribed. The transcribed information was then coded electronically using ATLAS.ti7©, and reduced to a series of keywords that captured the dominant themes. The coding process was designed to address the following questions: How is a household's perception of risk relating to different water sources shaped? How and to what extent do households choose between different aversion behaviours? Why do households reject or accept the public piped water service? We applied an eclectic coding approach, drawing on a mixture of attribute, structural, magnitude, and in vivo coding. Eclectic coding employs a compatible combination of two or more coding methods. Attribute coding is the notation of essential information from the data and demographic profile of participants. Structural coding is question-based coding that represents uses a topic of inquiry to categorize a data corpus; this type of code is suitable for in-depth interviews and open-ended question data. Magnitude coding has alphanumeric characteristics to describe frequency and intensity in the data. In vivo coding is drawn from participants' own words (Saldaña, 2013). Such a mixed and detailed coding technique was utilized to avoid early generalizations that might have neglected the complexity of household behaviours. We employed a "split" coding method, in which the data are divided into several "codable moments" (Bernard, 2011) We believe that this coding approach best serves the study's aims, allows for a nuanced analysis, and is an appropriate method for bringing together "richly diverse but disparate text" (Bernard, 2011). Additionally, we used quotes from interviews to further elucidate the links between risk perceptions and household behaviours.

3.5 Participants characteristics

Table 3.1 shows the characteristics of participants who contributed to the questionnaire. Fifty-six per cent of participants were homemakers, 26 per cent self-employed, 11.4 per cent permanent employees, and the rest were engaged in various informal activities and non-permanent jobs. The average duration of education was 9.6 years, slightly lower than for Bandung City's general population (10.5 years) (Statistical Agency of Bandung City, 2015c). Average monthly household income was 3,061,000 Indonesian Rupiah or IDR (US$ 245),[ix] and 33 per

cent of households had income lower than the Regional Minimum Income for Bandung City in 2014 (IDR 2,000,000 or US$ 160). The average participant's household consisted of five persons (the average household in Bandung City contained four persons) (Statistical Agency of Bandung City, 2015b). This inconsistency may be due to seasonal workers staying with their relatives, who can only afford housing on the outskirts of the city. This type of social mobility often remains undetected.

Table 3.1 Characteristics of participants of the semi-structured interviews in Ujungberung District, Bandung

Attribute	Description, mean (SD)
Age of participants, in years	40 (14)
Years of education of participants, in years	9.6 (2.8)
Family size	5 (2)
Monthly household income, in millions IDR	3.06 (1.75)
Monthly household income, in US$	245 (140)

NOTE: SD = standard deviation.

3.6 Water sources: description, quality assurance, and cost

We identified seven types of water sources (Figure 3.2) and made a cost estimate for each source (Table 3.2). Groundwater extracted through boreholes or dug wells is the most widely used source of water among participants; 48 out of 70 (69 per cent) of households in Ujungberung have access to groundwater (shallow wells or boreholes). The seven sources are listed below:

1) Metered piped connection. MP Cipanjalu distributes water by gravity and there is insufficient pressure to deliver water to the higher, northern parts of Ujungberung District. Only 11 per cent of households participating in the survey had access to piped water. A water meter installed in the consumer's residence records the volume of water used.
2) Individual or shared boreholes to a depth of 15 to 45 metres. Water is extracted from these with the use of electrical pumps. Boreholes are commonly equipped with a pipe casing assembly to protect water from contamination, a storage facility, and sometimes a household filtering device. Labour and material costs for siting a borehole and installing storage and filtering devices run between IDR 2,500,000 (US$ 200) and IDR 11,500,000 (US$ 921). The operation and maintenance costs depend on the pump capacity, duration of pump operation, and pump durability.
3) Individual or shared dug wells to a depth of 5 to 15 metres. Water is drawn using a simple bucket pulley system. We observed that dug wells are not equipped with proper protective structures and lids. The construction costs for a dug well vary from IDR 500,000 (US$ 120) to IDR 2,500,000 (US$ 200), and there is almost no regular operation and maintenance cost incurred for extracting water from this source.
4) Spring water (individual or communal access). In the case of an individual "connection", water from the reservoir owned by spring water entrepreneurs is delivered directly to individual dwellings. Water may also be delivered to a communal tank and further distributed to individual dwellings. Spring water does not undergo treatment and there is no water meter present. Water may be contaminated within the distribution pipes that are made from standard plastic

hosing. The hoses lie at the street edge at several distribution points, and are regularly passed by motor vehicles. Damage often occurs to the distribution hoses. Households pay IDR 15,000 (US$ 1.2) every month for this type of access, along with incidental repair fees that are split between fellow users. Households can also take spring water from communal tanks for a small fee, of only IDR 100 (US$ 0.01) per 3.3 litres.

5) Branded bottled water, or mineralized and demineralized drinking water produced by beverage companies, mainly sold through distribution agents. Water is sold in 600-millilitre, 1-litre and 19-litre bottles. The largest size is most commonly used in the household setting. Bottled water is priced from IDR 13,000 (US$ 1.1) to IDR 15,000 (US$ 1.2) for 19 litres of water. The bottled water industry is tightly regulated by the Ministry of Health and Consumer Protection Agency and adheres to a quality assurance standard to ensure safety.

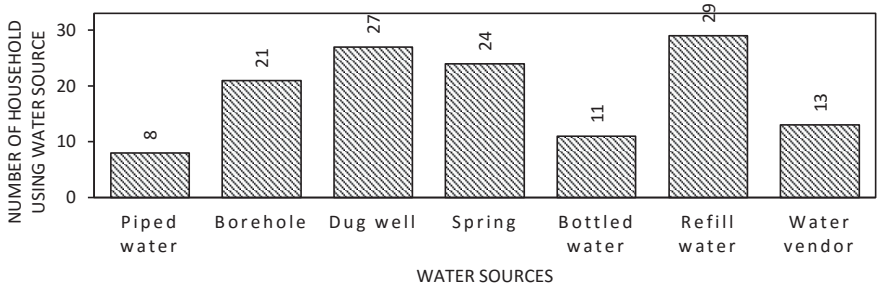

Figure 3.2 Numbers of participants using piped water, groundwater, spring water and commercial water. NOTE: The total number of households interviewed in this study is 70, but individual households that use two or more water sources were recorded more than once in this figure.

Table 3.2 Cost estimates for different water sources, in thousand IDR[(a)]

Water Source	Capital cost	Monthly cost[(d)]
Piped water	750	50–120
Borehole	2,500–11,500[(b)]	N/A[(b)]
Dug well	500–2,500	N/A
Individual spring water connection	200	15
Communal spring water	N/A	20–50
Branded bottled water	40[(c)]	70-170
Refill water	35[(c)]	26-50
Water from vendor	N/A	50–200

NOTES:
(a) Costs were estimated based on the information obtained from the interviews with households and local contractors in Ujungberung.
(b) The costs of borehole construction depend on the depth of drilling, pump capacity, the construction of overhead storage, and whether the costs are shared among neighbours. The monthly costs for boreholes depend on the pump operation and electricity tariff.
(c) The initial costs of bottled and refill water refer to the costs of empty polycarbonate (PC) and polyethylene terephthalate (PET) plastic bottles.
(d) For an average-size household.

6) Refilled bottled water, which is sold by small kiosks that treat raw water sources by using filtration sets and ozone/UV disinfection units. The treated water is supplied in refillable 19-litre plastic bottles and sold directly to households. Regulations require that refill water kiosks register with the local health office and pass water safety and sanitary inspections. Even so, we observed that some kiosks operate without quality certificates. Thus, the safety of their products remains questionable. The cost of this type of drinking water is much lower than for branded bottled water, at only IDR 3,500 (US$ 0.3) to IDR 5,000 (US$ 0.4) for 19 litres of water. Sixty-seven per cent of households use multiple water sources. Borehole/refill water and spring water/refill water are the most popular combinations observed.
7) Water sold by vendors from pushcarts or pickup trucks. Vendors sell spring water or resell piped water to areas where spring water or piped water supplies are inaccessible. Vendors may have a regular client base or sell water door-to-door in 10-litre containers priced at IDR 2,000 (US$ 0.2).

3.7 Risk Perceptions and Aversion Behaviours

Ninety-nine per cent of the 70 households interviewed stored water. Households stored water in different kinds of containers depending on use, such as bathing or drinking. Storage facilities varied from simple buckets and jerry cans to overhead storage tanks. Boiling is the dominant method of home water treatment, performed by 64 per cent of participants. Four per cent of households also use filtering. Eighty per cent of participants use multiple water sources and 64 per cent buy commercial water, i.e. water from vendors, bottled water or refill water. The following subsections relate the strategies of storing, treating and mixing water sources to the dimensions of access. Subsequently, we discuss the acceptance or rejection of piped water in the context of aversion behaviours.

3.7.1 Water storage, boiling and filtration

The fact that water quality improves through the settling of suspended solids is one of the main reasons that households store water. As a participant explained, “For drinking, we store it first, letting the dirt settle for two or three days.” Water storage often serves as a preliminary step before boiling. Households may also perform an additional simple cloth filtration process prior to boiling. Households worry about health risks resulting from skin contact with contaminants in water when washing. As one representative participant put it, “Storage is needed before filtering, before I use water for bathing and washing. The water is not good, it makes the clothes yellow. I am worried that it will irritate us when it touches our skin, if we don’t filter it.”

Households also boil water to improve water quality, reducing the microbial load. Households expressed a strong distrust of the quality of piped and groundwater as they do not drink piped and groundwater directly without boiling it. There are other treatment methods such as chlorination, but boiling is the preferred, most trusted, and also most widely adopted method to remove contaminants. Households treat water to attain a quality level similar to that of bottled/refill water. Twenty-six per cent of respondents who boil water associated boiling with improved water quality and 49 per cent stated explicitly that drinking non-boiled water can expose them to waterborne diseases. However, the motivation for boiling water does not always relate to the improvement of water quality and reducing risk. Twenty-five per cent of

households that boil water state that they do it simply to make hot drinks. The reasons behind boiling behaviour, in other words, are not all risk-related.

The rationale for storing water may depend on how the water is obtained. Commercial water vendors usually sell water regularly, at a certain time of day or day of the week: “From the vendor, water comes twice, once in the morning and once at 2 p.m.” Despite the general certainty of supply, households that buy water from vendors must adopt a storing strategy to ensure that an adequate quantity of water is always available. An interviewee explained, “We get it from a pickup truck. We can buy from this guy whenever we want, but I don’t want to buy water every day, only once every week or two.” Depending on how frequently they purchase water, households may possess different capacities to store water, but they all have some approach.

Households with access to individual spring water connections stored water mainly because of low supply pressure rather than issues of regularity or predictability. A spring water user stated, “our water supply is continuous. If I don’t store, it will go to waste” and “I can’t use water directly from the hose, it comes out slowly, I need to store it first so there will be enough available for when I need to bathe.” Those with access to metered piped water experienced problems of both continuity and low supply pressure, making the storing of water a necessity. Water can be stored using containers or buckets at the tap end, or in sealed containers connected to the water meter. In the latter case, water is distributed throughout the entire home plumbing system after it is collected. We also observed that piped water users sometimes applied “vacuuming” or installed electric pumps to draw water from the water mains. Subsequently, they stored the abstracted water in an underground tank, thus ensuring water availability. This strategy is in fact banned and the MWC has issued a warning highlighting the illegality of such practices. Assisted abstraction disadvantages other users who do not apply pumps or “vacuuming”. Nevertheless, it is still often used as a last resort during times of supply disruption.

For borehole users, water is stored after it is extracted from the borehole. A typical domestic setup consists of an electric pump that abstracts water from the ground and pumps it into an overhead tank. Gravity then delivers water throughout the entire home plumbing system. Because power cuts often shut down the extractor pump, interrupting the water supply, households store water in anticipation of running short. One respondent stated, “We have a lot of blackouts. I have to be prepared. If the electricity goes off, the water won’t come up.” Storing behaviour is also related to expense, in particular to the charges that are added to the electricity bill in relation to electrical pump use. Storing water reduces the frequency with which the pump turns on and off, thus reducing the electricity bill. One participant noted, “By storing, the pump will only need to turn on once every two or three hours, saving me money.” This also reduces wear, as well as the cost of pump maintenance or replacement.

3.7.2 The use of multiple water sources

According to the study results, households purchasing bottled or refill water for drinking considered other water sources to be of a poorer quality. Most of the perceptions relating to water quality are derived from the smell, colour and taste. Households also bought commercial water to avoid boiling, thus saving on energy costs and time. “We, women, need to save our time, we have so much to do, it is more practical to just buy bottled water, and put it on a dispenser when we want to

drink, rather than boiling and storing it", a homemaker argued. Bottled water and refill water were both popular alternative drinking water sources households turned to if they wanted to save on cooking fuel costs or when cooking fuel was scarce.

Sixty-six per cent of households preferred commercial water for drinking purposes, whether bottled water, refill water, or water bought from vendors,[ix] because they thought the water was "better". The MWC's distribution network and well structure are considered unable to provide safe, contaminant-free water, and there are concerns over poor sanitation and leakage from poorly managed septic tanks that can contaminate water sources. This perception is not without basis: 55 per cent of respondents are connected to septic tanks, most of which are poorly maintained, while almost half of the respondents directly dump their wastewater into the river.

For washing and other domestic purposes, however, households considered piped water, groundwater, and individual or shared access to spring water as their primary water sources. In these cases, commercial water from vendors was required only when the primary sources failed with respect to quantity. Households bought water in anticipation of seasonal scarcity. As a respondent who owned a shallow well put it, "In the dry season when there is not enough water, we just buy it, that's what everyone does." Households often supplemented water bought from vendors with groundwater to save money or to prevent "buying too much water". We also observed similar rationales within households that use a combination of piped and non-piped water sources (groundwater or spring water). They recognized such sources as complementary in regard to both affordability and seasonal continuity. Households using piped water and water from vendors occasionally used groundwater for water-intensive domestic activities such as washing and cleaning to reduce the volume used, thus cutting down on their water bill. If wells dry up in the dry season, the gravity-led network service (piped water) may provide an alternative supply. Figure 3.3 illustrates the degree to which various dimensions of access drive households to store water, treat water, and use multiple water sources, as previously described.

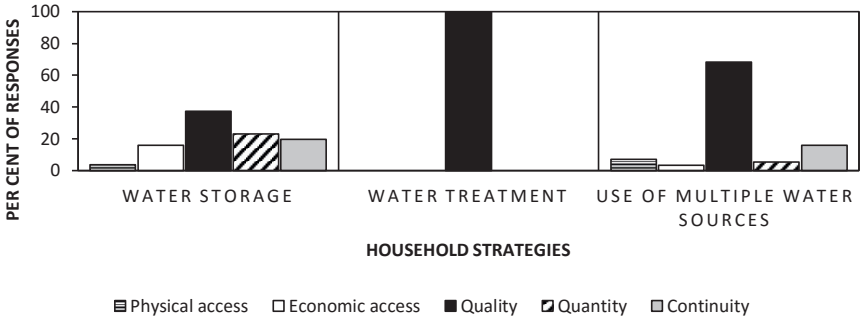

Figure 3.3 Percentages of responses relating aversion behaviours to the dimensions of access

3.7.3 Perceptions and attitudes towards piped water connections

We examined the perceptions of piped water connections held by: a) connected households (currently using the MWC service); b) past connected households (serviced by the MWC in the past); and c) never connected households.

Connected and past connected households have had first-hand experience of the service quality of the MWC. Households currently connected to piped water had a positive perception of the MWC service with regard to pressure level and quantity. However, negative perceptions of the MWC predominate, regardless of households' experience of the MWC service, and relate mainly to continuity, affordability, and water quality issues. The main concerns of connected households related to the contamination risks stemming from septic tank leakage, the poor taste and smell of piped water, and daily and seasonal continuity. Households also questioned the accuracy of water meters, which they believed led to unreasonably high bills. There were also concerns that demands for service improvements would remain unheard. One respondent elaborated, "The water from the piped network is not available every day, perhaps once every two days, at night. Should we stay awake every night? It's tiring. I feel that the water that we use does not fit with the numbers on our water meter. But there is nothing that can be done, they say that I still have to pay. So I paid, I don't want any trouble." Another householder stated, "I got tired reporting it, but at least I tried. Many others also report the problems, but the officer said that we should just accept it because there was no water there (at the source)."

Some previously connected households decided to cut off their piped water connection because the unpredictable service interrupted their daily schedules, and they had to "stay awake at night waiting for water to come". They also believed that piped water was a potential source of conflict among neighbours: "We also fought over water with our neighbours. So we use water from the well instead." Expense was a further reason for disconnection. MWC customers are required to pay a fixed service fee of IDR 10,000 (US$ 0.8) per month, and the monthly water bill depends on the volume of water used. Failure to pay bills resulted in network disconnection by the MWC. In these cases, reconnection requires all outstanding bills to be paid, and is charged at 15 per cent of new installation charges. The MWC Tariff Adjustment Plan explicitly states: "As part of its service improvement plan, the MWC had to shut down connections that could not be supplied and/or that did not pay the bills."(USAID, 2006). According to the United Nations (UN), disconnections as a result of non-payment should not result in an individual being denied access to a minimum amount of safe drinking water if that individual can prove that he or she is unable to pay (United Nations, 2007b). MWC appears not to adhere to these UN principles, and access to the minimum amount to meet basic needs is not guaranteed.

We classified households based not only on their piped water connection, but also on their attitude towards this service. Figure 3.4 shows the attitudes of connected households, ranging from strong rejection to strong acceptance (see Appendix 3.1). Almost half of the surveyed households strongly rejected piped water connections.

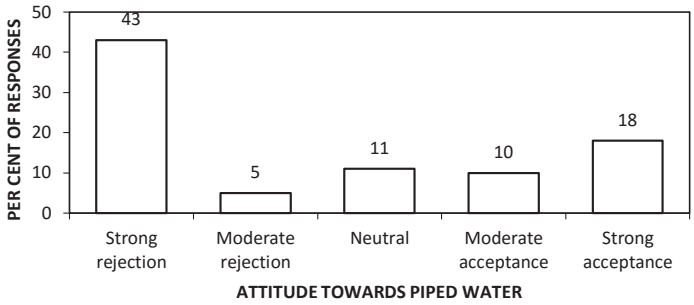

Figure 3.4 Households' attitudes towards piped water connections

The interviews revealed the issues underlying this rejection. Connection charges are the primary barrier (see Banerjee et al., 2008; Kayaga & Franceys, 2007). However, this is only one among several issues that keep households from connecting to the piped water supply. Households are unlikely to install a connection if they have access to an adequate supply of non-piped water. Participants also did not believe that the MWC piped water was an improvement over their existing water sources, and believed that switching to piped water might in fact leave them "worse off". Poor reliability mainly drove this reluctance. The MWC service is characterized by supply interruptions. As one respondent put it, "I see my neighbours, they have piped water and the water often doesn't arrive." This perception is supported by statistics suggesting that only 39 per cent of 129 villages in Bandung served by the MWC have a consistent, uninterrupted water supply (Bandung MWC, 2015). Households also choose to avoid monthly subscription fees and the time spent waiting for water during periods of interruption.

3.8 Towards a Framework of Risk Assessment and Aversion Behaviours

Based on the results of the study, we developed a framework that explains how households in Ujungberung District assess risks and respond in order to avert risks (Figure 3.5).

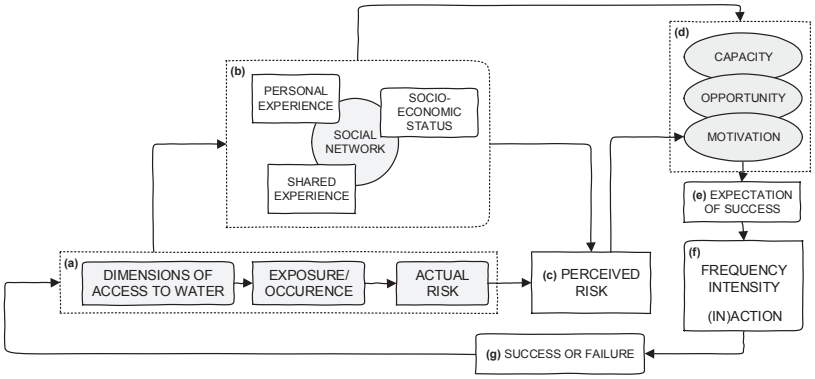

Figure 3.5 Framework of risk assessment and aversion behaviours among households in Ujungberung District, Bandung City

Section a of Figure 3.5 relates access to water and risk exposure; for example, poor quality and poor continuity of water will expose households to risks of illness and economic losses. With regard to water quality, there is no conclusive evidence as to health risks, as indicated by two studies conducted in Ujungberung District in 2015. Iqbal et al. measured the total coliform and faecal coliform bacteria in 77 households' water samples (Iqbal et al., 2015). They found that refill water is not necessarily safer than piped water after boiling, and that piped water users who turn to refill water are exposed to the same level of risk. Putri et al. (2015) performed a quantitative microbial risk assessment (QMRA) focused on the consumption of refill water and piped water. Their results demonstrated, by contrast, that piped water carries a higher probability of infection risk than refill water. Thus, based on these studies, refill water may or may not provide a higher level of protection to public health than piped water samples. This inconsistency may be a function of the variable quality of water. Although MP Cipanjalu is able to fully eliminate the coliform present in water, for instance, recontamination may occur through the distribution line. Thus, in the absence of better water quality information, householders that did not drink piped water rationally avoided health risks stemming from microbial water contaminants. The level of risk would be easier to assess if water quality were monitored regularly by state health offices or water entrepreneurs, ensuring that it consistently complies with human usage standards, and thus providing information for household decisions. In the absence of this information, the study results indicated that actual risks do not directly shape households' perceptions of risks, nor do they promptly lead to the adoption of aversion behaviours.

"In the absence of water quality information, actual risks do not directly shape households' perceptions of risks, nor do these risks promptly lead to the adoption of aversion behaviours."

Section b in Figure 3.5 shows the interactions of experience and social networks in shaping households' perceptions of risks. Perceptions of risk may develop via different pathways: personal experiences, shared experiences, the experiences of others, or combinations thereof. Households based their assessments of risk on their own experiences relating to the dimensions of access to water, e.g. their own exposure to poor-quality water or experiences relating to supply interruption.[x] Personal experience may be mediated by the socioeconomic backgrounds of individual households. We examined exactly how the socioeconomic characteristics of households affected risk beliefs among participants in Ujungberung, but the data do not reveal a clear pattern in this relationship.

Beliefs surrounding risk may also be based on a shared experience of challenges in the neighbourhood. For example, a previously connected participant decided to cut off his connection when he and his neighbours experienced similar reliability problems. "It's not only me, almost the entire neighbourhood experiences this", he said. The perceived risks and further adoption of aversion behaviours are not only derived from first-hand (personal and shared) experiences. Social networks also play a role in the dissemination of information about risks, and households' behaviours were often based on this information. For example, a respondent from a household that drank water obtained from vendors stated, "Everybody says that the water that I buy is fit for drinking."

An aversion to piped water in households never previously connected to the network is based, among other reasons, on allegations from neighbours concerning the unreliability and high cost of the MWC service. Spring water is highly regarded, partly due to local word of mouth about the results of the water quality testing performed by water entrepreneurs, rather than by individual households purchasing the water.[xi] According to one respondent, "People say that the spring owners take their water to the lab every three months. They have a permit. It's very clean, people here dare to drink it directly." The fact that some spring water entrepreneurs and refill kiosk owners test their water, and that this information is spread by locals, results in a lasting positive reputation for these sellers. Piped water originating from the MWC also undergoes regular quality testing at the point of distribution. Yet households do not appreciate the quality of piped water in the same way: "Water from the MWC is not fit for drinking, it's filthy." Despite the fact that the MWC's water is tested regularly, people worry about the recontamination risk that results from the vulnerable distribution network.[xii] Some households also suggested that unreliable septic tank facilities may jeopardize the safety of piped water at the point of consumption.

Water origin clearly affects the perceptions of water safety. While it is taken for granted that spring water is of high quality, river water, used by MWC, is expected to be unsafe, no matter how effectively it is treated. Even an officer of the MWC responsible for quality testing in the MP Cipanjalu revealed in an interview a reluctance to drink piped water. "I saw where it comes from," he stated.

To sum up, water-related risks are embedded in personal and shared experiences, and are disseminated by social networks. The interaction of personal experience and information on actual risk, circulated through social networks, explains households' perceptions of risk. However, this does not explain how perceived risks lead to certain behaviours. Our findings are consonant with the classic theory of planned behaviour, in which behavioural achievement depends on both motivation and the availability of requisite opportunities and resources (Ajzen, 1991) (as illustrated in Section d of Figure 3.5). Section 3.7 of this article identified health protection and economic loss as motivators that lead to varying degrees of action. Certain strategies are selected based on an inherent expectation that risk relating to poor water supply will be reduced (Section e of Figure 3.5).

The socioeconomic capacity of households may determine their ability to adopt certain strategies, and to what degree. A recent Nepali study suggests that poverty restrains households from adopting home treatment strategies (Katuwal et al., 2015). This supplements the findings of an older study, suggesting that years of schooling and a higher level of knowledge may lead to the adoption of filtering treatments and bottled water (Whitehead et al., 1998). Contrary to these findings, our survey found that 74 per cent of participants with an income lower than the minimum regional income boil their water, while only half of the participants in the higher-income group choose to do so. Likewise, 76 per cent of households with primary/lower secondary education treat their water, while only half of the respondents with secondary/post-secondary education do so. However, these numbers should be approached with care, since households with more income or education may be more likely to purchase bottled water, thus eliminating the need to boil. The study findings indicate that this is the case for branded bottled water, which predominates in richer households – participants with household income higher than the minimum regional

income are five times more likely to purchase branded bottled water than those whose income is lower than the minimum regional income.

However, similar proportions of participants with income both lower and higher than the minimum regional income use refill water. There is a similar pattern around the use of bottled water among participants with different education levels. The rate of branded bottle water purchase among participants with more than 15 years of education is almost four times higher than that among those with a low level of education. But the rate of refill water purchase is similar among participants with different levels of education. This indicates the high popularity of this type of water source among households in all income and education strata. It should be noted that these low- and high-end alternatives may be accompanied by varying levels of service quality and effectiveness (to the extent that certain strategies can reduce risks).

In addition to these choices, we identified a range of different actions, intensities and frequencies applied by participants who decided to adopt storing, treating and filtering techniques, and the use of multiple water sources. Households may decide to perform pre-treatment to reduce health risks associated with poor water quality, such as storage, filtering, or a combination thereof. Filtration methods range from simple cloth filtration to more advanced activated carbon, activated sand, zeolite sand, and manganese filtering. We expect that rich households will opt for the more advanced filtration, but the study was not able to demonstrate this since the overall level of filter use is very low in the sample.

Storage facilities vary from simple buckets placed in the bathroom to overhead storage tanks with a 1200-litre capacity. Households can choose from cheaper cloth filters and bucket-type storage to more advanced, but relatively expensive, filtering devices and overhead storage tanks. If water is required for drinking, householders may then, as discussed above, select boiling. This is an effective method for reducing health risk, and a method that will achieve a quality level similar to that of bottled water.

There is also some evidence to suggest that an individual's position within a household and the security of tenure may encourage or discourage the adoption of aversion behaviours. The decision to install a piped water connection, for instance, depends on the household hierarchy and where interviewees fit into this hierarchy. Patriarchal family hierarchy and multi-generational occupancy are common characteristics of households in western Java. Husbands or parents tend to be sole decision-makers, leaving little room for the opinions of women and young married couples living with their parents. Based on our observations, female household members with a low socioeconomic status were allowed to choose between simple, low-cost strategies, but had to consult their spouse or other male household members if more costly solutions were required.

Security of tenure also affected how households selected water sources. This was especially relevant for seasonal workers who temporarily reside in the area. Their status as tenants limits their ability to make decisions regarding the installation of new connections. Some participants refused to invest in the costly provision of water sources within a house that did not belong to them.

When people are motivated and have the capacity to act, the presence of opportunity may facilitate decision-making. Some spring water users have decided to have an individual spring water connection installed if the distribution network passes through their yards. Households currently connected to piped water also stated that their decision to connect was made when the local leaders arranged for a collective installation application made to the MWC. Households may re-evaluate their decisions if they perceive that a piped water connection does not reduce risks by a reasonable degree. This is reflected in the decisions of some households to disconnect. However, it should be noted that this type of re-evaluation may take place with regard to any decisions relating to any type of water source.

3.9 Conclusions and Recommendations

Aversion behaviour, or actions taken by households to mitigate damage associated with pollution, has been used previously to measure economic losses in response to environmental externalities (Smith et al., 1986). People are known to be risk averse, taking measures today to avoid the possibility of a negative impact in the future (Goodstein & Polasky, 2014). The present study focuses on these measures to avoid risk in the context of inadequate water supply services, which expose households to uncertainty, potential economic loss, and negative health impact on a daily basis. The results show a range of sensible measures taken by households in the absence of detailed water quality data.

"People are known to be risk averse, taking measures today to avoid the possibility of a negative impact in the future" (Goodstein & Polasky, 2014)

This study used qualitative inquiry to contribute to a deeper understanding of households' aversion behaviours, risk perspectives, and risk management strategies. We extended the scope of the definition of aversion behaviours from actions seeking to avoid health risk,[xiii] to include strategies aimed at uncertainty reduction and avoidance of economic loss. In Ujungberung District, households employed various aversion strategies to avoid negative impacts, including being "without water", illness resulting from the consumption of contaminated water, excessive time and energy spent acquiring water, and/or paying too much for water. Households maintain storing and treatment behaviours and use different water sources (or combinations thereof) based on their perception of risks that refer to the different dimensions of access to water. Such perceptions and decisions depend on complex interactions among personal experience, shared experience, socioeconomic attributes, and social networks.

This study was conducted in an area that enjoys a plentiful supply of spring water managed by local entrepreneurs in cooperation with community members. This type of arrangement may encourage trust in spring water, which shapes the choices that households make. We also limited the study to four behaviours: water storage, water treatment, the use of multiple water sources, and the decision to accept or reject a piped water connection. Other behaviours, not included in this study, have also been recognized, e.g. adjusting daily schedules in line with the availability of water, and obtaining water from relatives. These are outside the scope of the study but may be an interesting avenue for further research.

We first assumed that water storing is strongly associated with issues of continuity of supply (Vasquez, 2012) However, the findings show that households that use groundwater also apply storage strategies, and sometimes combine storage with filtration to reduce health risks. These observations should be considered further in future aversion behaviour studies because the more widely discussed aversion behaviours, at the moment, encompass only the purchase of bottled water and the implementation of household water treatment as responses to the perceived health risks of contaminated water (Abrahams et al., 2000; Jakus et al., 2009; Nauges and van den Berg, 2009).

The framework developed here may also be a useful starting point for similar research in the environmental risk fields as well as on social marketing measures. However, the framework is based on one case study and more research is needed to examine whether it is relevant in other contexts. It should be noted that application of the same methodology in a different situation might result in different results. We suggest that more detailed studies are needed in a range of situations, in particular to more fully understand the links between socioeconomic attributes, i.e. education and income, and risk perceptions.

Lastly, this research focuses on risk management at the household level. Households may reduce the effect of a poor-quality water supply by acting jointly with others in their neighbourhood. We recommend that future studies examine risk-reducing or risk-sharing mechanisms that occur at the community level.

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Appendix 3.1

The open-ended survey was comprised of the following questions:

- What are the sources of water being used on a daily basis? Are they private or shared? Can you tell me how you choose such sources?
- What are the specific uses for all the different water sources (drinking, cooking, hygiene purposes)?
- Do you buy water? What do you think of commercial water sources?
- Do you treat/store water at home? Can you tell me more about it?
- Do you have a piped water connection? Have you ever been connected? How was your connection arranged? How is/was your experience of piped water?
- If you do not have a piped water connection, suppose I am offering to connect you to piped water service. Would you be interested in connecting to this service?

The attitudes of respondents towards piped water were retrieved from the survey. The results are shown in Figure 3.4. Never connected and previously connected households were asked a hypothetical question about their attitude towards being offered a piped water connection. Connected households were asked about their experience of the piped water service.

Responses were classified as follows:

STRONG REJECTION: Participants express a strong rejection of a new piped connection, by simply saying no immediately. Participants may or may not elaborate on why they reject a piped water connection. Participants may have also been disconnected from piped water services.

MODERATE REJECTION: Participants express a moderate rejection of a new piped connection. Participants may say, “Not now, maybe later” or “No, unless…”; participants may elaborate on why they reject a piped water connection, mainly by expressing their distrust of piped water quality.

NEUTRAL: Participants express a neutral attitude towards a new piped connection and also a neutral perception of piped water’s dimensions of access, e.g. “It depends on the price”. In some cases, participants may also feel that they do not have the authority to provide answers, e.g. “I have to ask my husband” or “I’m only a tenant”.

MODERATE ACCEPTANCE: Participants express a moderate acceptance towards a new piped connection, followed by mentioning barriers that prevent them from having a piped water connection. For example, “I am personally interested, but…”

STRONG ACCEPTANCE OR ADOPTION: Participants express a strong acceptance of a new piped connection, by saying yes immediately. Participants may elaborate on why they accept a piped water connection. Participants may also be currently connected to the piped water service.

Notes:

i “Risk” may have a different meaning among scholars. Risk can be defined as the presence of threat, the possibility of adverse outcomes, and opportunities whose returns are not guaranteed. Risk contains the elements of potential loss, the significance of loss, and the uncertainty of loss. See Yates & Stone (1992).

[ii] The concept of “aversion behaviour” here refers to the one being used in behavioural and environmental economics, which is applied to assess people’s behaviour in regard to poor water supply. Aversion behaviour, or actions taken by households to mitigate damage associated with pollution, has been used to measure economic losses as a consequences of environmental externalities previously.

[iii] With the exception of Vasquez (2012), which measured the link between the perception of reliability and storing behaviour.

[iv] The hierarchy of the administrative areas in Indonesia is structured as follows: national government, provincial government, municipal/regency government, district and village. A city has the same administrative level as a regency, only a city has urban characteristics, whilst a regency has more rural characteristics. A city or regency consists of districts.

[v] Ujungberung District was previously part of Bandung Regency. In 1987, Ujungberung District was established as an administrative part of Bandung City based on Regulation of Bandung City No.16 Year 1987. In 2013, this district had 66,300 inhabitants. See Statistical Agency of Bandung City (2015a), *Ujungberung in Figures*, Bandung City, 128 pages.

[vi] The MWC does not deliver water via tanker or public standpipe. MP Cipanjalu is separate from the city’s main treatment plant and network in the central-north area of Bandung.

[Vii] The sample was determined based on the convenience sampling approach, using the equation in Isaac & Michael (1995), with a degree of accuracy of 0.1, a 90 per cent confidence level, and a population proportion of 50 per cent.

[viii] These strategies do not represent temporary measures to overcome seasonal water stress, but rather a large part of daily life in (peri-)urban Indonesia. This is similar to the case of Grace et al. (2013), whose work is focused on identifying coping strategies for climate variability-related water shortages in Nigeria.

[ix] Water from vendors in this area originates from springs.

[x]The link between personal experiences and perceptions is also observed in the case of flood risks. Isunju et al. suggested that households with personal experiences of flood exposure were more likely to perceive themselves as vulnerable. See Isunju et al. (2015)

[xi] This is unlike households in Canada that performed or asked for a water quality test of their private wells to be carried out.

[xii] Spring water actually faces similar risks, but respondents did not voice any concerns over spring water and contamination in the distribution network.

[xiii] Health risks present in water commonly originate from contact of water sources with poorly contained pathogens. See Campos et al. (2015)

[xiv] The term “aversion behaviour” is also used to describe the relationship between water reliability and storage practice. See Pattanayak et al. (2006) and Vasquez (2012).

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Chapter 4

"Bad" Piped Water and Other Perceptual Drivers of Bottled Water Consumption in Indonesia

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4.1 Abstract

In countries that have established and have been maintaining a robust piped water system, bottled water has been perceived to be of better quality than piped water. We argue that piped water and bottled water cannot be easily compared in the Indonesian context. Drinking from tap water has never been accepted as the norm as piped water has no guarantee of purity and safety. The substantial marketing efforts of the bottled water industry highlight the appeal of bottled water in regard to, not only good water quality and physical health, but also taste, convenience, mental health, and social and environmental values. Despite many negative social and environmental issues associated with bottled water, this enigmatic commodity is becoming “the” drinking water in Indonesia and is inseparable from modern life.

Keywords: *bottled water, commodity perceptions, content analysis, Indonesia, piped water*

4.2 Introduction

Bottled water is a global enigma. Strict water quality control requirements becomes the main reason why people put high trust to this commodity (Ferrier, 2001). On the other hand, the development of bottled water industry is commonly characterized by many negative environmental and socioeconomic issues. Scholars have suggested that consuming bottled water results in high environmental impacts relating to extraction, processing, packaging, transport, and disposal (Parag & Roberts, 2009; Mangoting & Surono, 2006; Endaryanta, 2007). Despite these impacts, the consumption of bottled water in the North America and many European countries roughly doubled from 1998 to 2003 (Wilk, 2006). In this context, it is often asked why people would opt for an environmentally harmful commodity when they can drink tap water (Wilk, 2006). Therefore, it is not surprising that research has addressed the private rationality of bottled water consumption (Parag & Roberts, 2009; Viscusi et al., 2015; Olson, 2013).

In the last decade, bottled water has been discussed as a direct substitute of piped water. The increasing substitution of piped water with bottled water was related to a growing distrust of the quality of piped water (Parag & Roberts, 2009; Doria, 2006; Saylor et al., 2011). In Northern countries that maintain a robust piped water service, the status of bottled water has been elevated to such a degree that it is seen as a better quality option than piped water. Some critics believed that bottled water consumption was based on the irrational perceptions of consumers as bottled water was not in any way superior to piped water (Viscusi et al., 2015).

"In Northern countries that maintain a robust piped water service, the status of bottled water has been elevated to such a degree that it is seen as a better quality option than piped water."

In contrast to the condition of Northern countries, piped water services are a luxury for the majority of residents in Southern countries like Indonesia. This contrast can be attributed to a distinct development trajectory where the networks have never been planned, designed, and built for the majority (Kooy & Bakker, 2008). Piped water was originally provided for residents from the higher social classes: the white European population, *ambteenar* (the colonial civil officers), and local elites, while people of lower status relied on traditional water sources such as shallow wells and surface water for domestic purposes, including drinking (Ministry of Public Works). Piped water coverage has increased significantly in the 21st century, albeit from a very low level. By 2011 piped water coverage still only accounted for 8.9% of the total population of Indonesia (see Figure 4.1). The coverage slightly increased to 10.2% by 2015 (National Statistical Agency, 2015).[i] The reasons for the poor progress of piped water network expansion include, among others, increasing demographic pressure, problems with raw water supply, and outstanding debt arrears of many municipal water companies interrupting on-lending for large-scale water supply investment (the Regulation of Government of Bandung City, 2014; WIRA Study Team, 2012).

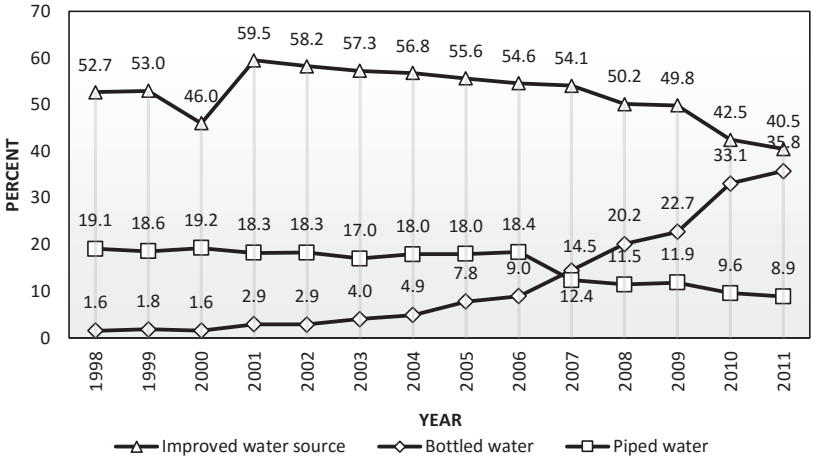

Figure 4.1 The trend of access to improved drinking water source, piped water, and bottled water consumption in Indonesia (National Statistical Agency, 2015). Improved water sources includes piped water, borehole, protected dug well, protected spring, and rain water.

The Indonesian market for bottled water has been growing since bottled water was introduced in 1901 and since Aqua, the most well-known Indonesian brand, was established in 1973 (see Box 4.1). The Association of Indonesian Producers of Packaged Drinking Water (Aspadin) claims that 700 bottled water companies now operate in Indonesia, producing more than 2000 brands.[ii] Bottled water comes in various sizes, from 240 mL to 19 Litres. The largest 19 Litre size is popularly known as *galon*. This bottle size contributes 71% to overall bottled water sales, and is commonly used in household and office settings (Poeradisastra, 2012).

Box 4.1: The History of Bottled Water in Indonesia

Bottled water was introduced to the Indonesian market in 1901 by a Dutch businessman, Hendrik Freerk Tillema, who established the bottled water company Hygeia in Semarang, a city on the north coast of the island of Java. At that time, the idea of buying water in bottles was viewed as preposterous by local people, as free drinking water could be obtained from shallow wells or springs. Bottled water was originally intended only for the European population and was hence known as "Dutch water". In 1973, the company PT Golden Mississippi (later to be renamed PT Tirta Investama and in 1998 merged with the French company, Danone), built its first commercial mineral water production plant in the city of Bekasi, West Java: Aqua. Aqua was initially sold only in certain selected stores that served expatriates, reinforcing the image of bottled water as a product for the higher social class. However, Aqua began expanding in 1978 as a result of market growth that exploited the high potential of the lower classes. The expanding target market of bottled water is demonstrated by the shift in bottled water price. In 1974, Aqua was sold in 950 mL glass bottles at a price of IDR 75, almost twice that of gasoline (IDR 45). By 2015, the average price of Aqua per Litre was IDR 2,619, which was much lower than the gasoline price of the time (IDR 7,400) (Hadipuro, 2010). At present, Aqua Danone employs more than 12,000 workers in 18 factories throughout Indonesia (Bekasi, Citeureup, Mekarsari, Sukabumi, Subang, Pandaan, Wonosobo, Klaten, Mengbal, Brastagi, Lampung, Pasuruan, Cianjur, and Bogor).

National bottled water consumption contributes 85.1% to total consumption of beverage products, and is growing at a rate of 12.5% per year (Dewi, 2015).[iii] Bottled water is now the top drinking water in Indonesia (Ministry of Health, 2013). Aqua holds the biggest industry market share (46.7%), with the result that "Aqua" has become the generic name for nearly all forms of bottled water (Ratnasari, 2014).

This paper attempts to explain the phenomenon of bottled water's rising popularity in Indonesia. We seek to understand the perceptual drivers of bottled water consumption in Indonesia from the perspective of producers and consumers. We first describe how bottled water links to piped water. We then explore the appeal of bottled water by elucidating how bottled water users perceive this commodity. Consequently, we also explore how bottled water companies present this commodity to the market. Studies, particularly in the USA, conclude that the consumers of bottled water are "victims of hype" since bottled water is not necessarily purer, safer, or better regulated than piped water (Parag & Roberts, 2009; Viscusi et al., 2015; Olson, 2013). For the Indonesian consumers seeking assurance of water safety, bottled water is not merely a "hype", but rather the only choice of hydration source that is safe and readily available. Furthermore, the substantial marketing efforts of bottled water industry also highlight the appeal of good water quality and physical health, but also great taste, convenience, mental health, and social and environmental values. As a result, bottled water is now the most trusted drinking water source and had become inextricable from the modern life despite many negative social and environmental issues associated with this commodity.

4.3 Method

Whilst this is predominantly a review paper, we do present some primary research results. For the scope of our analysis and following the legal definition, bottled water is defined as mineral water that has been processed and packaged that is safe to drink (Minister of Industry, 2012).[iv] To explore the perceptions of bottled water users, we performed a rapid online survey of 271 bottled water users in November 2016 using the Google Form platform (see Appendix 4.1). 148 participants residing in Bandung City and 139 participants residing in Jakarta were recruited online through friend referrals using a snowball strategy.[v] The following open-ended questions posed to the participants of the online survey: (1) why do you choose bottled water? (2) what makes you choose a particular brand of bottled water? (3) how do you think bottled water is linked to environmental and social issues?

We then applied content analysis to the participants' responses regarding their perceptions and choices of different water sources. Content analysis is one of qualitative methods that systematically analyses and reduces data to interpret meanings from research phenomenon by creating categories, concepts, or models (Elo et al., 2014). Past studies suggest that there are at least six factors affecting decisions relating to the consumption of bottled water, namely, organoleptic, water quality, convenience, price, lifestyle, and environmental concerns (Ferrier, 2001; Parag & Roberts, 2009; Viscusi et al., 2015; Doria, 2006; Hobson et al., 2007). We applied these six factors and new ones derived from the data collected, as categories in our analysis (see Table 4.1).

Additionally, to understand the various images of bottled water produced by the industry, we collected promotional materials of the most frequently advertised bottled water brands in Indonesia: Aqua, Nestlé Pure Life, VIT, Ades, and Prima that circulated through both conventional media (television) and social network sites from 2010 to 2016 (see Table 4.2) as our sampling frame. Every fourth advertisement was included in the social network sites were selected, counting from a randomly chosen starting point (An, 2003). A total of 698 social media advertisements and 24 video advertisements were analysed. Event-reporting advertisements were excluded. We then performed content analysis for systematic analysis of verbal and visual communication messages (Elo & Kyngäs, 2008). Similar categories to those shown in Table 4.1 were used to analyse responses. The advertisements we examined contain visual imagery and text. We identified patterns in the text by using the key-word-in-context. Visual imagery was analysed by characterising the model/actor (gender, age, and occupation), behaviour or specific actions, events depicted, setting, and in the case of video advertising, the audio message. A peer debriefing where portions of data were shared and how codes are assigned to text were discussed with colleagues to test codes validity (Wahyuni, 2012). We performed reliability analysis using Cohen's Kappa statistics to determine consistency among coders. The inter-coder reliability was 0.701 ($p \leq .0.001$) (Landis & Koch, 1977).

Table 4.1 Categories operationalized in the content analysis

Categories	Description
Categories derived from previous studies	
Organoleptic	Bottled water has a good or sweet taste, pleasant odour, good visual appearance, and is fresh.
Water quality	Bottled water has a superior water quality or pure. Details in terms of microbial, physical, or chemical parameters (e.g. bacterial count, mineral content, etc.) may also be given.
Convenience	When the practicality of bottled water is emphasized, e.g., bottled water can be consumed anywhere, ease of access.
Lifestyle	When activities reflecting particular opinions, routines, and the behaviour of an individual, group, or culture (e.g. healthy lifestyle, sporting activities) are depicted or associated with bottled water.
Environmental concerns	When a concern for environmental issues, such as disposal of packaging, water source protection and conservation, is highlighted.
Price	When an issue relating to the cost of obtaining drinking water is mentioned.
Categories emerging from the data	
Cognitive performance	When drinking bottled water is associated to an improvement in focus, concentration, and other cognitive abilities.
Psychological issues	When it is indicated that drinking bottled water will improve mood, reduce worries, and lift spirits.
Health	Drinking bottled water brings health benefit, e.g. hydration, kidney health, etc.
Socio-economic concerns	When a concern for socio-economic issues, such as clean water provision and employment, is highlighted.
Trust and accountability	When a participant indicates their confidence that bottled water companies (or a particular bottled water brand) are able to guarantee the safety of their products.

Table 4.2 Bottled water brands, companies, and promotional materials included in this study

Brand	Company	Promotional material
Aqua	Tirta Investama/ Group Danone	Facebook page (N=1095; n=274) 19 video advertising
Nestlé Pure Life	Akasha Wira International	Facebook page (N=442; n=112) One video advertising
VIT	Tirta Investama	Facebook page (N=398;n=100) Two video advertising
Ades	Coca Cola Amatil Indonesia	Facebook page (N=266; n=67) One video advertising
Prima	Sinar Sosro	Twitter (N=578 tweets; n=145) One video advertising

NOTE:
N= the total number of promotional graphics posted on the social networking sites.
n= the number of promotional graphics sampled for analysis.
Prima's Twitter account was used to mine data instead of its Facebook page since Twitter appears to be the primary social networking site for communication with consumers used by this brand.

4.4 Results

4.4.1 Online survey

The participants in the rapid online survey were made up of 68.3% female respondents, 59.6% were 26 to 35 years old, 80.8% were married, and 60.4% of married participants had incomes of more than IDR 10,000,000 and 59.7% of single participants had incomes of between IDR 2,000,000 and IDR 7,500,000 per individual. More than 90% of respondents had been using bottled water for a minimum of five years, and 20% had been a consumer of bottled water for more than 20 years. 87.1% of participants used 19 L bottles for home use, and 66.2% of participants bought bottled water once or twice per week. Meanwhile, 80.1% participants use 500-600 mL bottled water for non-domestic purposes, and 14.6% of these participants buy bottled water every day and 47.4% buy bottled water once to twice per week. The major brands preferred by participants are Aqua Danone, followed by VIT, Ades, and Nestlé Pure Life. Figure 4.2 shows the results of content analysis to participants' response in regard to their preference of bottled water. Meanwhile, 48.1% of respondents perceive that bottled water companies bring negative socio-environmental impacts (i.e. water resource commercialization that leads to inequity of access to water for local people, packaging waste problem, water resource degradation). Meanwhile, 20.2% mention some positive socio-environmental impacts of bottled water companies (i.e. opening job opportunities, economic value from recycled packaging waste, and positive impact from corporate social responsibility activities). The rest of respondents did not provide clear answers or did not answer at all.

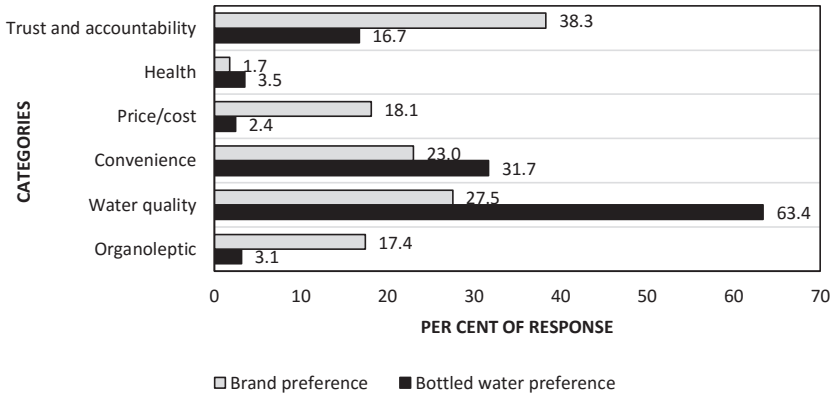

Figure 4.2 The percentage of participants' responses in regard to the reasons of preferring bottled water compared to other drinking water source and the reasons of preferring a particular bottled water brand compared to other brands (n=287).

4.4.2 Advertising analysis

There was a near-equal distribution in targeting men and women in Aqua and Nestlé advertisement samples. Most online promotional material samples of VIT brand

broadly targeted women while Prima mostly targeted men. Ades did not show a clear tendency of targeting a specific gender based on its advertisements. We observed that the segment target for all brands seem to be those who are city-based, younger than 45 years old, from middle- to high-classes economy, and highly-educated. Health concern was the most common category (24.1%) to appear in the sample of promotional materials posted in social network sites of bottled water brand, followed by lifestyle (12.5%), psychological issue (10.5%), environmental issue (8.6%), cognitive performance (7.3%), convenience (7%), water quality (6.3%), organoleptic (3.2%), and socio-economic issue (3.2%) (see Figure 4.3). Meanwhile, we did not put any categories to 12.5% of promotional materials since it reports miscellaneous events sponsored by the bottled water brands.

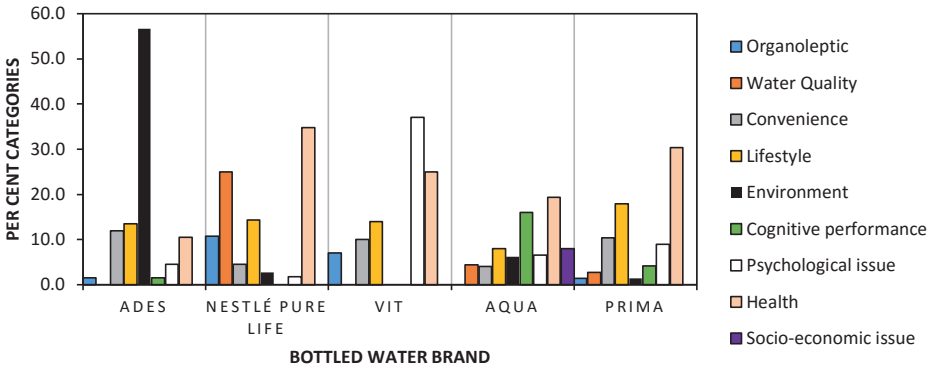

Figure 4.3 The percentage of categories of promotional materials posted in social network sites of bottled water brands (n=1396).

4.5 Discussions

4.5.1 Bottled Water and "Bad" Piped Water

While studies often compare piped water with bottled water as substitutes, such a view does not apply to the Indonesian context for two reasons. Firstly, the coverage of piped water is low. The rate of new connection is unable to keep up with population growth. The low progress of piped water is also explained by high raw water supply deficits, low commitment and competence of the municipal water companies towards professional service, poor financial performances of municipal water companies, high idle capacity (the amount of water produced by water treatment plant which cannot be distributed due to limitations of pipeline network) and non-revenue water (water that is produced by the municipal water companies and lost before it reaches the consumers), and low investment allocation from the local government.[vi]

Secondly, piped water quality does not meet drinking water quality requirements at the point of use. By law, it is compulsory for piped water companies to produce "drinking water" that meets health requirements and is safe to drink. Existing water treatment plants are able to produce water that meets this standard (Putri et al., 2015). Several public piped water suppliers even produce their own brands of bottled water (Prasetiawan, 2015).[vii] The practice of "bottling tap water" also occurs in the

USA (Olson, 2013). However, piped water companies are often unable to maintain the quality of water supplied to the most distant point-of-use; the quality deteriorates as it pass through the distribution network (Putri et al., 2015). There are complex problems that reduce water quality along the distribution networks: aging pipes and maintenance difficulties that occur due to reduced accessibility resulting from the road and electrical network; sewage contamination from treatment reactors such as septic tanks; and illegal connections to the water supply infrastructure.

In relation to those complex problems, a recent study in Bandung revealed that the people have proclivity to distrust the ability of piped water companies to purify water (Nastiti et al., 2017). The source of piped water company's raw water comes from rivers that often visually appear polluted, whilst most bottled water company's advertisements suggest that their raw water originates from springs in forests in the hinterland. People are also aware of the problems of re-contaminations of piped water as they often observe that the distribution pipes are situated close to on-site waste water reactors (Nastiti et al., 2017). As a result, piped water is considered unsafe unless certain household water treatments (i.e., boiling and/or filtering) are performed prior to consumption. In addition, a participant in our online survey stated that "piped water companies use many chemicals in treating their water". Therefore, the residual chemicals are believed to be potentially harmful to health. This statement is in contrast with the message conveyed by Aqua which states that their product is "processed by nature".

'The aversions to piped water rising from issues related to piped water providers' problems and consumer distrutst and aste, nurture a common belief that piped water has no guarantee of purity and safety and, therefore, drinking from tap water has never been accepted as the norm."

Additionally, an aversion to piped water is also related to taste. For example, people refuse to drink piped water because of the strong taste of disinfectants (i.e. chlorine) (Nastiti et al., 2017). This attitude contrasts with the suggestion that the presence of disinfectants eliminates microbial risk. The aversions that rise from these complex problems then nurture a common belief that piped water has no guarantee of purity and safety and, therefore, drinking from tap water has never been accepted as the norm.[viii] Such common beliefs can be well related to trust and accountability, which was articulated from the online survey. Trust and accountability were the third most important drivers in choosing bottled water, after water quality and convenience. Respondents believed that bottled water companies should take full responsibility for the safety of their products, and can be held accountable should failures occur. The citizens may not be aware of the legal requirement for public companies to provide safe potable water.[ix] Instead they shift to bottled water rather than demanding accountability of those public companies that have been failing to maintain water safety along the distribution network. Consequently, the bottled water industry fills the gap left by public water companies that are unable to provide readily available drinking water.

4.5.2 Bottled Water Perceptions: from good quality water to "ethical" commodity

The consumption of bottled water is associated with the consumers' perception regarding the quality of bottled water, accordingly, health (Parag & Roberts, 2009; Saylor et al., 2011; Hu et al., 2011). Indeed, the image of superior water quality that appeals to health concerns is significant in bottled water video advertising. In

addition, most participants of our online survey also associated bottled water with excellent water quality. In general, bottled water is mainly related to “purity”, which works under the assumption that everything coming from nature must be “pure” and “healthy”. Aqua, formerly called Puritas, emphasizes in their advertising that their water originates from protected natural resources, and that the company is able to “lock in” nature’s goodness which results in a pure and good quality product. Interestingly, people often depend on their multisensory experience to decide whether water is safe to consume (Pink, 2015). For example, a participant decided that groundwater was unsafe to drink because “it smells like sand”, and another said, “I can smell iron” (in the water).

In the 1970s, research communities gathered evidence illustrating the impact of microbial water contamination on health (Shaw et al., 1977; Craun, 1979). Current promotional materials correlate microbial quality mainly with hygienic handling during production and distribution processes and how packaging is able to prevent the recontamination of water. For instance, Nestlé Pure Life accentuates the importance of cap seal protection to guarantee the quality of water, and to ensure its authenticity. In addition, Nestlé Pure Life also discourages the use of groundwater by emphasizing the poor sanitary conditions in Indonesia with its #stopairolahan (“stop treated water”) hashtag. Two issues concerning chemical parameters were raised by the participants of our online survey: participants choose bottled water primarily to avoid water that contains unwanted chemicals, such as groundwater with high iron concentration, and secondly, to obtain water with an appropriate mineral content. For example, advertising of Nestlé Pure Life exploits the former issue by suggesting that the consumption of boiled and re-boiled (piped) water is dangerous.[x]

Bottled water advertisements do not only relate health to microbial and chemical safety, but also to the other medical functions of water. The most distinct one is the discourse of hydration, which is linked to various healthy lifestyle in bottled water marketing (Race, 2012). The Indonesian Regional Hydration Study (THIRST) suggested that 50% of Indonesians suffer from mild dehydration (Hardinsyah et al., 2010); a finding that has been further disseminated through Aqua’s advertisements. Bottled water companies have positioned themselves as the main source for providing hydration and accordingly have been promoting regular consumption of their products.[xi] This contention is rather supported by a common narrative as exemplified through a statement given by a participant: “for drinking, we have no other choice”. Hydration is also related to other health benefits, i.e., weight loss, bone regeneration, and organ functioning. For instance, VIT, with its series of advertisements, “make it light with VIT”, suggests that optimal hydration will lessen the burden of waste products to the kidneys.

Box 4.2: Bottled Water and Mental Health

The evidences for linking hydration and mental health are somewhat mixed (Lieberman, 2010; Secher & Ritz, 2012; Armstrong et al., 2010; Cheuvront & Kenefick, 2014). Yet, the #kurangAqua advertisements seem to considerably attract the young urban middle-class who often use the phrase "lacking of Aqua" in daily conversations to suggest poor cognitive performance among their peers. Interestingly, a similar connection between hydration and cognitive performance was made in 2008 by two German scientists who filed a request for the right to claim on labels of bottled water that "regular consumption of significant amounts of water can reduce the risk of dehydration and a concomitant decrease of performance". However, the European Union (EU) has subsequently issued a ban which prevents bottled water companies from making this claim on their products (EFSA Panel on Dietetic Products, Nutrition and Allergies, 2011).

Moreover, Aqua's recent campaign associates hydration not only with physical health, but also with mental health, that is cognitive and psychological performance (i.e. focus, concentration, and mood). Aqua's promotion of the #KurangAqua ("lacking of water") hashtag in social media popularizes the idea that bottled water use is the most accessible and a rational way of cognitive performance improvement. Aqua further claims that "research proves that not drinking enough water results in mild dehydration, which further results in a decrease in cognitive performance and mood" (see Box 4.2). Meanwhile, VIT is promoting the usage of the #ringaninaja ("make it light") hashtag to promote, aside from renal health, the potential benefit of good hydration in reducing anxiety.

Convenience sits among the top three reasons for choosing bottled water in our online survey; 33.4% of participants perceived bottled water to be a convenient product. Scholars have defined "convenient products", in this case bottled water, as those that are conscientiously attuned to certain practises of modern life (Hawkins & Race, 2011). In modern life, people turn to bottled water to avoid boiling water for it is perceived to be time-consuming and fuel-intensive (Nastiti et al., 2017). As one participant in our online survey put it, "we don't have to boil water first," and "it saves cooking fuel". As a result, people can drink safe potable water "anytime, anywhere" as conveyed by bottled water advertisements.

In addition, bottled water delivery service contributes most to the convenience of bottled water use for home and office, which is similar to observations made in Bangkok (Hawkins & Race, 2011). The delivery service offers a convenient solution for overcoming problems of transporting drinking water such as the weight, the need for a vehicle, and the heavy traffic of Indonesian cities like Bandung and Jakarta. Convenience chain stores are increasing in number in almost all urban residential areas. Some chain stores, such as Indomaret, market their own brand of bottled water which is usually cheaper than other brands. VITSA (Delivery Ready VIT) and Aqua Home Service increase access to these companies product in residential areas by offering opportunities for housewives to become distributors. As one participant put it, "they sell close to home, you can request the water to be delivered."

Size becomes central here and makes up a specifically contemporary sociocultural condition of Indonesian cities. Domestic spaces are the domain where Indonesian households often entertain a large number of guests and bottled water is perceived

to be a convenient object in such social occasion. For example, a single bottle containing 240 mL of water offers convenience when serving water to these guests: "I don't have to wash the dishes," as argued by one participant. Different sizes are then attuned to activities outside domestic space. For example, a single bottle containing 500 to 650 mL of water is usually used by consumers when they are not at home. These sizes are usually portrayed in advertisements that promote hydration and healthy, active lifestyles (Klein & Huang, 2008). Bottled water brands we examined also frequently embark on educational campaigns that are related to adequate hydration, healthy eating, regular exercise, and various fashionable physical activities such as running and cycling to work.[xi]

Bottled water brands, particularly Aqua and Ades, also promote socially and environmentally conscious lifestyles in their advertising. Aqua claimed that their Corporate Social Responsibility's (CSR) program, Aqua Lestari, promotes water and environmental conservation at production facilities, carbon footprint reduction, green distribution, and community development, including participatory water, sanitation and hygiene programs (Tirta Investama, 2014). Ades focuses on concerns relating to the management of waste through the campaign messages "choose, drink, crush" and "small steps bring the change" which promote their sustainable packaging that reduces plastic waste volume (Wirandani, 2013).

"Ethical" brand images promoted by bottled water companies often contradict related negative environmental and social impacts (Hawkins & Emel, 2014).[xii] Participants in our online survey raised serious concerns regarding the depletion of water resources and reduction in access enjoyed by local populations to water resources at extraction points. High volume and continuous water extraction by the bottled water industry increases environmental concerns and social conflicts that relate to decreasing quantity and quality of groundwater and springs for drinking and irrigation (Wahyuni, 2011; KruHa, 2012; KruHa, 2010). Social conflicts often take place at extraction points far from the cities. Widely reported conflicts have occurred in Klaten, Sukabumi, and Serang, where Aqua has planned or established water extraction points (KruHa, 2010).[xiii] Participants of our online survey agree that the bottled water industries provide the local population with opportunities for income generation that involves product distribution and the CSR projects, such as the Aqua #1for10 program. This CSR program is about donating 10 Litres of clean water to poor communities for every one Litre of water bought by consumers. However, there is evidence of frictions occurring between those who are benefiting and not benefiting from the CSR projects, e.g., those who have and have not been able to gain employment in bottled water production facilities (Ambarwati, 2013).

4.6 Conclusion

We conclude that bottled water is indeed an enigma. Despite its popularity, it is considered to be an unofficial "indicator" of the failure of the public water supply system[xiv] which is not expected to match the quality of bottled water at the point of use in the near future.[xv] Even if piped water companies were able to maintain the quality of potable water at the point of use, substantial marketing efforts would be required to attract people who are generally not accustomed to drinking piped water. The poor quality of piped water supply, in addition to the deterioration of groundwater and surface water sources, encourages people to consume commercial bottled water. At the same time, as a survey participant indicated, the rising popularity of

bottled water reduces the motivation of public companies for taking immediate action to improve and maintain the quality of piped water.

Bottled water is laden with many negative social and environmental problems. However, bottled water companies have managed to downplay these issues and create brands associated with environmental and social conscience. Despite these green advertisements, the reality of the environmental and social problems that relate to the bottled water industry linger and some environmental groups are still voicing strong objections against new developments of bottled water factories (KruHa, 2010). However, bottled water is still the most trusted and preferred drinking water source. The image of bottled water promoted in advertising not only highlights the appeal of good water quality and physical health, but also great taste, convenience, mental health, and social and environmental values. Bottled water has become, as one participant in the online survey conveyed, “inseparable from our modern life.”

“Although bottled water is laden with many negative social and environmental problems, bottled water is still the most trusted and preferred drinking water source in Indonesia. The image of bottled water promoted in advertising not only highlights the appeal of good water quality and physical health, but also great taste, convenience, mental health, and social and environmental values.”

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Appendix 4.1

Topics asked to participants of the online survey:

- Demographic information: city, gender, age, education, marriage status
- Bottled water consumption: year of consumption, buying frequency and most frequently bought size and brand for home and outdoor use, reasons for choosing bottled water and bottled water brands, bottled water advertisement, bottled water and socio-economic and environmental issue.

Notes:

[i] In addition, the existing pipes network is laden by the problems of poor water quality, interrupted service, insufficient disinfection, and infrastructure ageing. Citizens without piped water service rely on groundwater, water vending, and other sources.

[ii] As stated by R. Andaru Eko Oetomo, the Chief of Aspadin of Central Java in Aspadin Expo 2016 in Semarang, 19-21 April 2016.

[iii] This figure is probably underestimated since it excludes the consumption of refill water, non-branded bottled water sold in *galon* size sold in small kiosks that treat raw water by using a compact treatment set, generally made up of filtration and ozone or ultra violet disinfection units. Although there is no official record, the Association of Drinking Water Supply and Distribution (Apdamindo) estimates that an 85 fold increase in the number of refill water kiosks occurred from 1997 to 2008 (Darmawan, 2009).

[iv] We exclude oxygenated water, hexagonal water, demineralized water, and refill water

[v] Total samples were determined where the population proportion was 25%, the sampling error was 10%, and confidence level was 95% (Parker & Rea, 2005). The populations of Bandung and Jakarta were set at 2,470,802 and 10,270,000 people, respectably (Bandung Statistical Office, 2016 & Jakarta Statistical Office, 2016). Although selection bias is generally considered to be the main limitation of this approach, snowball sampling using social network sites is particularly useful in targeting “hidden populations” when it is impossible to build a sample frame to obtain a probabilistic sample, which is, in this case, bottled water users in Bandung and Jakarta (Brunet, 2012).

[vi] As presented by Subekti, Executive Director of PERPAMSI Perpamsi (the Association of Indonesian Water Supplier), in a Focus Group Discussion with the Secretary General of the House of Commons of Indonesia, in Jakarta, June 18, 2015). Any increase in the access coverage of improved water sources is dominated by non-piped water sources.

[vii] For example, the Piped Water Company of Bandung City and Jember City. There may be more public companies that produce bottled water, but official records are limited due to small production capacities, inadequate marketing, and a lack of certification by the National Food and Drugs Administration and the Indonesian National Standard (SNI 01-2552-2006) for bottled water products (Prasetiawan, 2015).

[viii] This may also be the case in many other countries with “bad” piped water. For example, a large proportion of Latino families in the USA avoid drinking piped water because they fear that they will fall ill as a result. This aversion was suggested to be justified because Latino immigrants originate from areas where piped water is not drunk (Hobson, et al., 2007).

[ix] In Bangkok, piped water safety is guaranteed by a waterworks authority, and evidence suggests that the results of regular water quality testing are available to consumers (Hawkins & Race, 2011).

However, in Indonesia, there is limited up to date information with regard to the safety of piped water available and accessible to the public. The Bandung Piped Water Company only mentions compliance with turbidity standards on its official website. Water quality information is not available on the website of PT Aetra Air Jakarta, whilst the most recent water quality information on the website of PT PAM Lyonnaise Jaya is from 2013.

[x] As the advertisement puts it: "when water is heated, the level of nitrite is elevated and the nitrite will bind oxygen in the water"

[xi] The hydration function of bottled water is particularly promoted during Ramadhan through, for example, Aqua's hydration campaign that promotes the health maxim of consuming eight glasses of water per day.

[xii] Prima associates itself with popular sports such as tennis and football, as well as with extreme sports such as climbing and skateboarding. VIT occasionally associates its brand with running and cycling. Marathon and cycling are among the most popular urban sports at present which not only promote health, but also individual achievement.

[xiii] Negative socio-environmental issues are central in the annulment of the Water Resource Law of 2004. Supporters of the annulment believed that this Law allowed a high degree of private sector involvement in water resource management affairs, including the participation of bottled water companies in drinking water provision, but failed both to limit private sector activities, and identify those accountable for any negative externalities occurring due to these activities (including extraction, production, and distribution of bottled water products) (the Constitutional Court of the Republic of Indonesia, 2013).

[xiv] The existing water extraction points of Aqua are located in Sumatera Island (Brastagi and Lampung), West Java (Mekarsari and Kubang in Sukabumi and Cipondoh in Subang), Central Java (Mangli in Wonosobo and Klaten), East java (Pandaan, Kebon Candi), Bali (Mambal), and Manado (Air Madidi).

[xv] Unwritten "policy" among the staffs of the Ministry of National Planning (BAPPENAS), as stated by a Ministry official during a personal communication in August 2016.

[xvi] Massive investment is required to restore a distribution network that currently contributes to the re-contamination of piped water. Instead of improving water quality, the most pressing challenges for piped water companies revolve around expanding access, reducing idle capacity and waste, overcoming raw water quality and quantity problems, and other technical drawbacks (Ministry of Public Work, 2015).

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Chapter 5

The effect of differentiated access and mitigating behaviour on household water supply expenditure: a case study of Bandung City, Indonesia

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5.1 Abstract

Water supply inequity, both in the sense of access and water affordability, remains a challenge. This paper evaluates access to water and water expenditure across households of different income groups in Central Cikapundung Basin, Indonesia. Higher income households are more likely to use piped water, bottled water, or the combinations thereof and have higher water expenditures than their lower income counterparts. We estimated the 'hidden' mitigation costs of groundwater extraction and water boiling and highlight the importance of incorporating mitigation costs when assessing the impacts of poor service quality of water supply towards household water expenditure and affordability.

Keywords: *access to water, affordability, equity, mitigation cost, water expenditure, Indonesia*

5.2 Introduction

Although the United Nations celebrated achieving the drinking water target of the Millennium Development Goals (MDGs) in 2012, some issues surrounding the water supply sector remain unsolved (Goff & Crow, 2014). Equity is one of the remaining challenges. Bradley and Bartram (2013) suggested that there are large and often consistent inequities experienced by different segments of society. But, what is equity? Previously, Goff and Crow (2014) challenged the notion of equity by emphasizing that the widely used definition of equity only focuses on the potability of water, without considering the full range of uses of domestic water supply.[1] Domestic water does not equate to only 'drinking' water but also includes water needed for livelihoods and maintaining the home. This paper agrees with this statement and probes the issue of inequity with respect to two concerns: inequity of access and inequity in regard to the cost burden of water.

"Domestic water does not equate to only 'drinking' water but also includes water needed for livelihoods and maintaining the home."

Firstly, regarding the issue of inequity of access, there is a persistent exclusion of the poor in accessing improved water sources despite the millions of individuals who gained access within the last 15 years (UNICEF & WHO, 2015). Since 2011, the WHO-UNICEF Joint Monitoring Programme for Water and Sanitation (JMP) has commenced to disaggregate water and sanitation data by wealth quintiles to understand how they vary across socioeconomic level (Satterthwaite, 2015). The improvement of access is mostly experienced by the populations in the high quintiles, and poorer households are reported to be more likely to rely on unimproved or unsafe water sources (UNICEF & WHO, 2011; Yang et al., 2013). Access to piped water is also often restricted to the richest population quintiles, while the poor continue to rely on non-piped water sources, such as hand pumps (UNICEF & WHO, 2011). These disparities of access to improved and safe water sources are masked by regional averages (UNICEF & WHO, 2011).

However, these disparities are often difficult to measure considering the multifaceted nature of access in developing countries. For example, in many developing countries, having access to some types of improved sources does not necessarily mean that the water from such sources is safe or continuous. Piped water services, the most improved mode of provision, often do not function properly to deliver potable or continuous water directly into dwellings (e.g. Lee & Schwab, 2005). A household can rely on multiple modalities to cope with these deficiencies and to obtain adequate water for their daily uses. Households often employ multiple water sources in an attempt to match source with intended use (Neumann et al., 2014). A study in Bandung revealed that households often combine piped water with unimproved water sources, such as an unprotected dug well, water from vendors, or bottled water (Nastiti et al., 2017). These facts are often undetected in official statistics such that coverage is overestimated–the number of households accessing improved water sources on a full-time basis may actually be lower than recorded.

Secondly, equity is not only about varying levels of access across socioeconomic groups. Abubakar (2016) suggested that concentrating on the equity of access alone offers a biased picture of performance and exaggerates the level of accomplishment. Equity also concerns whether water is economically accessible for the poorest segment of the population. The principle of equitable access requires that any

payment for water service should be affordable for all. It demands that poorer households should not be disproportionately burdened with water expenditures as compared with their richer counterparts (United Nations, 2007). Affordability requires that costs related to water should not prevent a person from accessing safe water and should not compromise his or her ability to enjoy other basic rights. In urban areas, it is suggested that the poor pay much more for a litre of water obtained from private vendors than the richer households (UNICEF & WHO, 2011).

> Equity concerns whether water is economically accessible for the poorest segment of the population."

In order to examine affordability, the costs of varying water sources across different income levels should be measured. The costs related to water are often measured by the expenditure of connection of water utility and consumption of water (Kayaga & Franceys, 2007; The Coalition Eau, 2008). The Coalition Eau (2008) released a report stating that water is considered affordable for households if the ratio of water utility expenditure and total disposable income is one per cent in developed countries and 2.5% in developing countries. A common benchmark set as the affordability limit is the 'five-per cent rule', in which, as a rule of thumb, water utilities and donors assume that water supply projects cannot cost more than five per cent of a user's total expenditure (Fankhauser & Tepic, 2007; Gomez-Lobo, 2001; McPhail, 1993). In Indonesia, the Regulation of Minister of Internal Affairs Number 23/2006 stipulates that the water utility tariff burden shall not exceed four per cent of household income. In some European countries, water is also considered unaffordable for the poorest segment of the population (UN Economic Commission for Europe & WHO, 2012). For example, water bills in Hungary and Poland are 4.6% and 7.9% of the total disposable income, respectively (OECD, 2010). Affordability is also often measured based on the total household expenditure (Luffman, 2006). Regardless of the affordability limit, McPhail (1993) suggests that households, even low income ones, are actually willing and able to pay seven to ten per cent of their total household expenditure for individual water connections, thus breaking the 'five-per cent rule'.

Calculating monthly water expenditure is not always straightforward, particularly in areas without universal access to piped water. This raises a concern previously mentioned: the multifaceted nature of access. Aside from water bill expenses, piped water users might also spend their income on costs related to water deficiencies (Ghosh et al., 2016). When safe water is in short supply, households undertake mitigation behaviour to compensate for the lack or poor quality of piped water, mainly by using multiple water sources, storing water, and performing in-house water treatment (Nastiti et al., 2017). Such strategies also entail costs that in this paper are described as mitigation costs. A study in Kathmandu, Nepal, (Pattanayak et al., 2005) described how mitigation costs vary across types of water users and income. The wealthier households had higher mitigation costs, which the authors suggest is because they have more resources to invest in water treatment, storage, and purchases. These mitigation costs were almost twice as much as the current monthly water utility bills. This then raises question to what extent households are burdened by a poor or absent public water supply.

Through data derived from a household survey in Central Cikapundung Basin, Bandung, Indonesia, this study aims firstly to evaluate access to water and household water expenditure across households in different income groups and secondly to understand the effect of the expansion of piped water access, by taking

into account mitigation costs, on water expenditure and water affordability through the development and analysis of a set of scenarios.

5.3 Materials and Method

5.3.1 Study area

This study was carried out in the Central Cikapundung Basin, located in the north-central area of Bandung City, the capital city of West Java Province. This basin mainly consists of housing with a small percentage of commercial, educational, industrial and hospital areas. Dense housing covers 10.57 km of the 15.5 km (68.2%) length of the Cikapundung River flowing across Bandung City (Bachrein, 2012). The Cikapundung River serves as a raw water source for piped water supply service provided by the Municipal Water Company (MWC) of Bandung City. The MWC only provides water service to 25% of the total city population (Government of Bandung City, 2014). Maintaining water quality and supply continuity in the distribution network are the MWC's major problems, which are caused by a limited raw water supply, high water losses, and broken transmission and distribution pipes (Government of Bandung City, 2010). These problems result in non-compliance with the drinking water quality standard at the point of use and a non-continuous water supply for many of the company's customers (Putri et al., 2015). On average, water is distributed 15 hours per day through a rotation system (Government of Bandung City, 2010).

For those without piped water service, groundwater withdrawn from shallow wells and boreholes is the most popular source of water in Bandung City. The National Socio-economic Survey (2013) documented that 57.7% of households in Bandung City obtained water for domestic activities, such as bathing and washing, from such sources (National Statistical Office, 2013). However, it is unclear whether the national survey recorded the use of multiple water sources since there is also evidence that piped water users also retain the use of groundwater due to inadequacies of piped water service (Nastiti et al., 2017). The limited capacity of the MWC in providing adequate water supply has put pressure on the city's groundwater resources. More than one million m^3/month of groundwater is extracted by industries, tourism activities, and vertical housings; this number is underestimated as extraction through illegal boreholes and individual home wells is not documented (Government of Bandung City, 2014).

5.3.2 Household Survey

This study employed data from a 2012 household survey conducted in Central Cikapundung Basin, Bandung City, Indonesia. The household survey selected 1,100 out of 11,471 households in Central Cikapundung Basin through a cluster sampling method with α 95%, 3% margin of error, and the proportion of population 0.25 (Rea & Parker, 1997). Table 5.1 shows the profile of the survey respondents. The survey classified households into four income groups: Q1, Q2, Q3, and Q4.

Table 5.1 Respondents' profile

Income Groups	**Q1**	**Q2**	**Q3**	**Q4**
Total respondent (n)	57	315	519	209
Proportion of respondent (%)	5.2	28.6	47.2	19.0
Household income (in thousand IDR)	<500	500 - 1000	1000 - 2000	2000
Household income (in US$)	<35	35-70	70-140	>140
Monthly household expenditure (in thousand IDR)	Med:520 SD: 172	Med:965 SD: 240	Med:1350 SD: 406	Med:2020 SD: 870
Monthly household expenditure (in US$)	Med:36 SD: 12	Med:68 SD: 17	Med:95 SD: 28	Med:141 SD: 61
Proportion of households owning home-based businesses (%)	23	21	25	26
Proportion of households with secure tenure (%)	86	88	87	87
Proportion of households with permanent housing structure (%)	68	70	82	89
Average household size (person)	4	5	5	5

Note: All conversions of IDR to US$ were based on the exchange rate of the Bank of Indonesia at 7 September 2015. As comparison, the minimum regional salary of Bandung City was IDR 1,271,625 (US$89) in 2012. SD=standard deviation; Med=median. Median value is used since it better represents the central tendency of data compared to mean value.

We found that the expenditure of some households in Q1 is higher than their stated income. Some expenses may be paid from borrowed money (Bandung Statistical Office, 2016). Moreover, the income stream from informal type of work is often unstable; thus, it is difficult for household members to track precise monthly income and expenditures since these households live day to day.

5.3.3 Analysing access to water and water expenditure across four income groups

This study sought to investigate how access to water, water expenditure (in Indonesian Rupiah/IDR or US$), and the water expenditure to total expenditure ratio or WTER (as a %) differ across households with different income levels. The percentage of access in each income group was determined by the number of households using a certain type of water source divided by the total number of household belonging to the income group. The access level was determined for two different usages of water: drinking and bathing. Water quality is crucial for drinking, whereas water quantity and continuity are more important for bathing and other water-intensive usages related to hygiene. WTER serves as a measure of affordability. Rather than being based on income, affordability is based on total expenditure; it has received more attention since it reflects all household spending priorities and tends to provide more accurate information than income, which rarely captures all sources of revenue (Fankhauser & Tepic, 2007; Luffman, 2006). To determine if there were statistically significant differences in monthly water expenditure and WTER among Q1, Q2, Q3, and Q4, we employed a rank-based non-parametric test, the Kruskal-Wallis Test (Chan & Walmsley, 1997; Kruskal & Wallis, 1957).

5.3.4 Scenario analysis

To understand the possible effect of an expansion of access on water expenditure, we performed a scenario analysis. Our approach follows Swart et al. (2004) and Postma and Liebl (2005), in which a scenario is seen as a systematic framing of

uncertain possibilities to compare alternative future images. Our scenarios consisted of two components, access and usage, as shown in Figure 5.1.

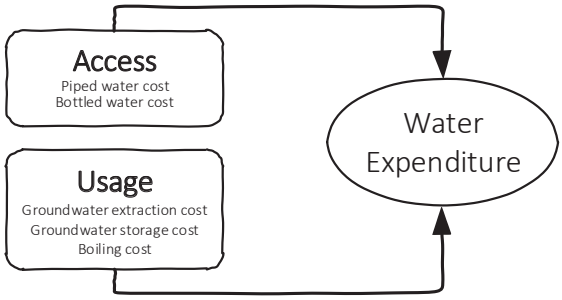


Figure 5.1 A scheme of scenarios to understand the effect of access and usage on water expenditure

"Access" in Figure 5.1 represents the level of piped water coverage, while 'usage' signifies mitigation behaviour, i.e. the decisions of households to extract groundwater and perform in-house treatment and storage. A recent study in Bandung indicated that the perception of service quality is an important factor underlying households' acceptance of piped water service; these perceptions also affect the decision to choose among different strategies to mitigate the effect of poor water supply, i.e. using piped water together with groundwater from a borehole or dug well, treating water, and storing water (Nastiti et al., 2017). The study also revealed that borehole users commonly use storage facilities to deal with excessive water pump operation. Thus, we considered water boiling and groundwater extraction and storage as mitigation behaviours in our scenarios.

We consequently developed three static scenarios to estimate water expenditure under different levels of access to piped water and different user decisions to sustain or abandon groundwater extraction:

- **Scenario 0 (base scenario)**. We supposed that the level of access to piped water and the usage of water were as recorded in the survey. Thus, household water expenditure ($WAT\_EXP_{scenario\ 0}$) was calculated as the sum of the recorded water expenditure in the Cikapundung survey ($WAT\_EXP_{recorded}$), groundwater extraction and storage costs, and boiling cost (see in Equation (5.1)). The estimation of groundwater extraction and storage costs and boiling costs is provided in Table 5.2. These costs are only accounted for when the survey indicate that a household use groundwater and/or boil water.

  $$WAT\_EXP_{scenario\ 0} = WAT\_EXP_{recorded} + groundwater\ extraction\ cost + groundwater\ storage\ cost + boiling\ cost \quad \textbf{(5.1)}$$

- **Scenario A.** In this scenario, we supposed universal access to piped water, meaning that all households in Q1, Q2, Q3, and Q4 have access to piped water supply. The households continued to extract and store groundwater as the piped water is not continuously delivered. To estimate the cost of incorporating water expenditure for piped water for those who in Scenario 0

were without access to piped water, we used standard regression analysis (see Equation (5.2)).

$$WAT\_EXP_{estimate} = a + b\ TOT\_EXP + c\ H\_OWN + d\ H\_TYPE + e\ HH\_MEM + f\ H\_BUS + g\ PIPED + h\ BOTTL + \varepsilon \quad \textbf{(5.2)}$$

In our analysis, the variation in water expenditure was determined by the socio-economic attributes and access to water. We assigned monthly water expenditure ($WAT\_EXP_{estimate}$), in IDR, as the dependent variable or the response variable. We also assigned the following independent variables as indicators of socio-economic status: total monthly household expenditure (TOT_EXP), in IDR; housing ownership (H_OWN); and housing type (H_TYPE). We also took into account the total number of household members (HH_MEM) and the availability of a home-based business (H_BUS) to represent the quantity of water demanded by households. Meanwhile, piped water access (PIPED) and bottled water use (BOTTL) were also included in the analysis as independent variables.

Table 5.2 The costs of mitigating strategies commonly employed by households in Bandung, Indonesia

Strategies	**Cost component; *Type of Cost***	**Assumption**	**Cost estimate, in IDR (US$)**
Water treatment (boiling)	Monthly expenditure of LPG (liquid petroleum gas) used for boiling water; *Fixed*	The proportion of cooking fuel spent for boiling drinking water=13.9% (Clasen et al., 2008). Monthly LPG demand of typical urban Indonesian households= 12 kg (Pranadji, Djamaludin, & Kiftiah, 2010). The lowest retail price for LPG in 2012= IDR 5850 per kg.	9800 (0.7)
Water storage	The amortized monthly cost of overhead storage construction; *Fixed*	The capital cost for household storage polyethylene tank[a]=IDR 1,575,000 (US$ 110) Storage tank lifespan=15 years Interest rate = 12%[b]	25,000 (1.7)
Shallow groundwater extraction	The amortized monthly cost for well construction; *Fixed*	The capital cost for household dug well constructions[a]= IDR 1,500,000 (US$ 105) Well lifespan=10 years[c] Interest rate = 12%[b]	24,000 ($ 1.7)
Deep groundwater extraction	The amortized monthly cost for well construction and electrical pump set up; *Fixed*	The capital cost for household borehole constructions (including electrical pump)[a]= IDR 8,000,000 (US$ 560) Well lifespan=10 years[c] Interest rate = 12%[b]	129,000 (9)
	Monthly expenditure for pumping water using electrical pump; *Variable*	Pump operation time per day= 3 hours A typical water pump has a capacity of 350 VA, with power factor of 0.8[a]	Energy cost for pumping water[d]

[a] Based on interview with local contractors

[b] The bank of Indonesia's credit interest rate year 2012. As comparison, Pattanayak et al. (2005) used 15% of interest rate.

[c] Pattanayak et al. (2005) estimate well lifespan to be 15 years, but this 15-year estimate was optimistic due to a declining groundwater table.

[d] Energy costs for pumping water was estimated based on pump capacity, pump operation time, and tariff class of electrical capacity installed within household. Electricity tariff differs based on the capacity (in Volt-Ampere or VA) installed in a dwelling. The 2012 unit price for capacity of 450 VA, 900 VA, 1300 VA, 2200 VA, 3500 VA, and 6600 VA are IDR 360, IDR 445, IDR 790, IDR 795, IDR 890, and IDR 1,330 per VA, respectively.

Water expenditure in this scenario further considers the costs of piped water estimated through multiple regression analysis. Thus, household water expenditure in scenario A ($WAT\_EXP_{scenario\ A}$) was calculated as the sum of the recorded water expenditure in Cikapundung survey ($WAT\_EXP_{recorded}$) for those originally with access to piped water or water expenditure estimated by multiple regression ($WAT\_EXP_{estimate}$) for those previously without access to piped water, boiling, and groundwater extraction and storage (see Equation (5.3)).

$$WAT\_EXP_{scenario\ A} = WAT\_EXP_{recorded}\ or\ WAT\_EXP_{estimate} + groundwater\ extraction\ cost + groundwater\ storage\ cost + boiling\ cost \quad \textbf{(5.3)}$$

- **Scenario B**. In this scenario, we supposed universal access to piped water as well as a change in the usage of water. In this scenario, we assumed that households no longer extract and store groundwater. Thus, household water expenditure in this scenario ($WAT\_EXP_{scenario\ B}$) was calculated as the water expenditure estimated in Scenario A ($WAT\_EXP_{scenario\ A}$) minus the costs spent for groundwater extraction and storage (see Equation (5.4)). Moreover, we assumed the water quality of piped water is unlikely to change and thus it cannot be consumed directly without treatment. Thus, the boiling costs remained unchanged.

$$WAT\_EXP_{scenario\ B} = WAT\_EXP_{scenario\ A} - groundwater\ extraction\ cost - groundwater\ storage\ cost \quad \textbf{(5.4)}$$

5.4 Results

5.4.1 Access to water and water expenditure across income groups

The Central Cikapundung Basin survey recorded different water sources that households in different income groups used for drinking and bathing. We found that not all households used the same source of water for bathing and drinking purposes. Although bottled water was well-accepted in all income groups, the rate of bottled water purchase was 1.6 times higher in Q4 households compared with Q1 households. Instead, seventy per cent of Q1 households opted to select non-bottled water sources for drinking purposes, mainly spring groundwater withdrawn through shallow wells and boreholes (see Figure 5.2(a)).

For bathing purposes, the proportions of households with access to piped water increased as income rose. Access to piped water in Q4 households was three times higher than in Q1 households. In contrast, almost half of Q4 households relied on groundwater or spring water for bathing, and that proportion decreased as income rose (see Figure 5.2(b)).

However, it is not obvious from Figure 5.2 (a) and (b) that many households combined different water sources for drinking and bathing. Figure 5.2(c) shows the proportion of households who combined piped water, non-piped water, and/or bottled water. In Q1, 47% of households used multiple water sources, and 53% of the households in this group relied solely on a non-piped water source. The proportion of households using multiple water sources increased as income increased, with 55% of households using multiple water sources in Q2, 66% in Q3, and 75% in Q4. The proportion of households that combined piped water and bottled water also increased as income rose.

Next, we investigated water expenditure and WTER in households with different levels of income. The Central Cikapundung Basin household survey results showed that when income rose, water expenditure also increased. Seventy-seven per cent of Q1 households spent less than IDR 50,000 (US$3.5) for water, while none of these households spent more than IDR 100,000 (US$7) per month. In comparison, only roughly 30% of Q4 households spent less than IDR 50,000 per month for water, and 35% of Q4 households spent more than IDR 100,000 (US$7) for water. In Figure 5.3(a), households with access to piped water had relatively higher water expenditure compared to those who without access to piped water. The households that used both piped water and bottled water spent the most for water. There were households within all income groups that stated that they do not pay for water. These households do not have access to piped water or buy bottled water but instead rely on natural water sources.

Consequently, we performed a Kruskal-Wallis H tests to determine if the monthly water expenditure (IDR) and WTER (%) differ significantly among the four income groups. We concluded that the distributions of monthly water expenditure and WTER differ among all groups, as assessed by visual inspection of boxplots (Figure 5.3(b) and (c)). Statistically, there are significant differences in the mean ranks of water expenditure ($\chi^2(3) = 147.62$, $p = <.001$) and WTER ($\chi^2(3) = 21.797$, $p = <.001$) among income groups.

We consequently used a post-hoc test with pairwise comparison (Dunn, 1964; Elliott & Hynan, 2011) to determine which groups have a significant difference. This post hoc analysis revealed statistically significant differences in the amount of water expenditure between all income group combinations ($p<0.05$). There were also statistically significant differences in the WTER between Q1 and Q3, Q1 and Q4, Q2 and Q3, and Q2 and Q4 income groups but not between Q1 and Q2, or Q3 and Q4. The WTER of Q1 households was similar to that of Q2 households. Likewise, the WTER of Q3 households was similar with that of Q4 households. The results of the post-hoc test suggested that Q3 and Q4 spend more for water from their shares of total household budget than Q1 and Q2 households.

5.4.2 Scenario analysis

For the purpose of scenario analysis, we aimed to understand to what extent access to piped water affects water expenditure using standard multiple regression analysis without neglecting the effect of bottled water purchase and other socio-economic attributes. The multiple regression model predicted water expenditure with statistical significance ($F(7,1087) = 185,058$, $p < 0.05$, adj. $R^2 = .541$). With other variables held constant, the total monthly expenditure, access to piped water, and use of bottled water significantly affect water expenditure. The effect of having piped water at home

on water expenditure was further explored in our scenario analysis using the following multiple linier regression expressed as Equation (5.5).

$$ln\ WAT\_EXP_{estimate} = -5{,}988 + 0{,}701\ ln\ TOT\_EXP + 0{,}081\ H\_OWN + 0{,}445\ H\_TYPE + 0{,}123\ ln\ HH\_MEM + 0{,}220\ HBUS + 3{,}922\ PIPED + 4{,}495\ BOTTL \quad \textbf{(5.5)}$$

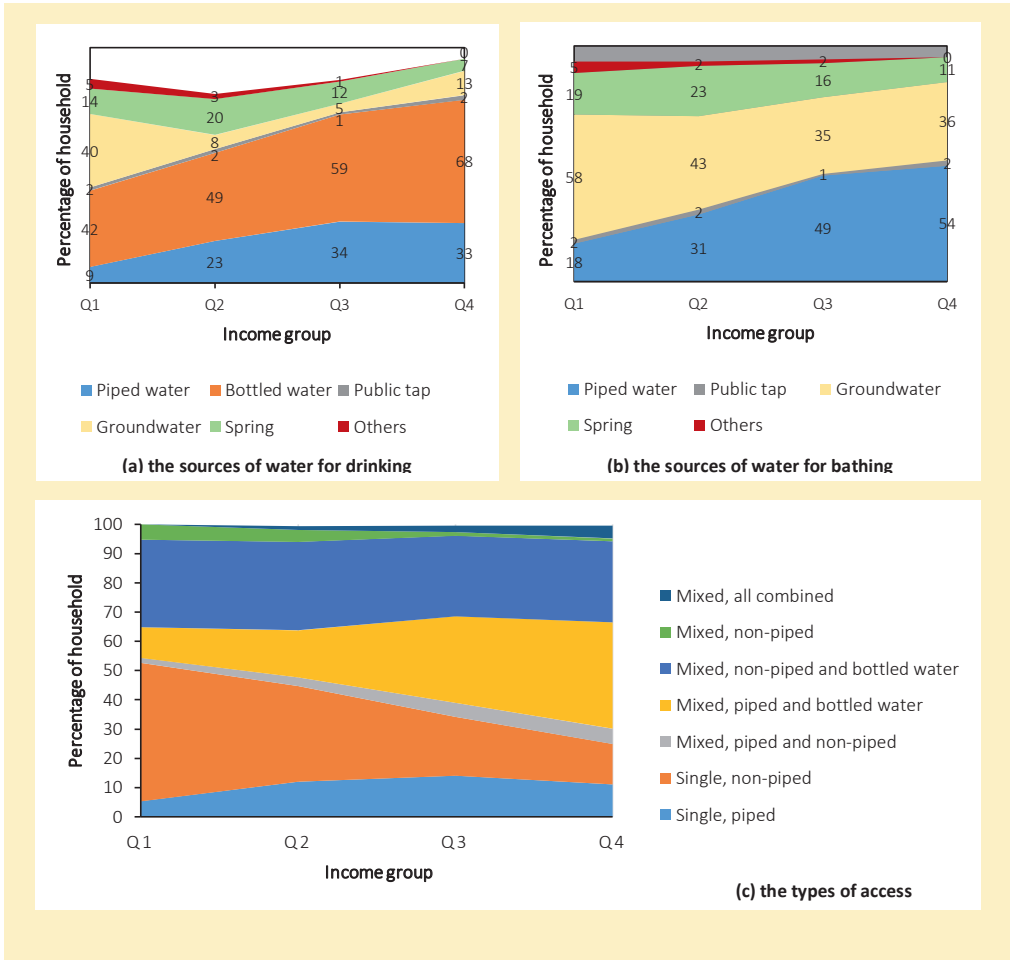


Figure 5.2 Access to water based on income group. The graphs shows the proportion of households using particular water source(s) compared to the total population within an income group (%). Note for (a) and (b) that a household can use more than one water source for one usage (bathing/drinking).

We then estimated the effect of the adoption of various mitigation strategies on water expenditure. As Pattanayak et al. (2005) suggested that mitigation costs increase

significantly as income increases, we assumed the same trend when selecting the mitigation strategies used by households in our scenarios. Our post-hoc Kruskal-Wallis test previously suggested that Q3 and Q4 households had a higher WTER than Q1 and Q2 households. Therefore, in our scenarios, we supposed that Q1 and Q2 households applied lower cost mitigation strategies, while Q3 and Q4 households had greater freedom to choose more expensive strategies. In our scenarios, Q1 and Q2 households employed individual dug wells and did not install overhead storage facilities, while Q3 and Q4 households employed individual boreholes with electrical pumps and overhead storage facilities.

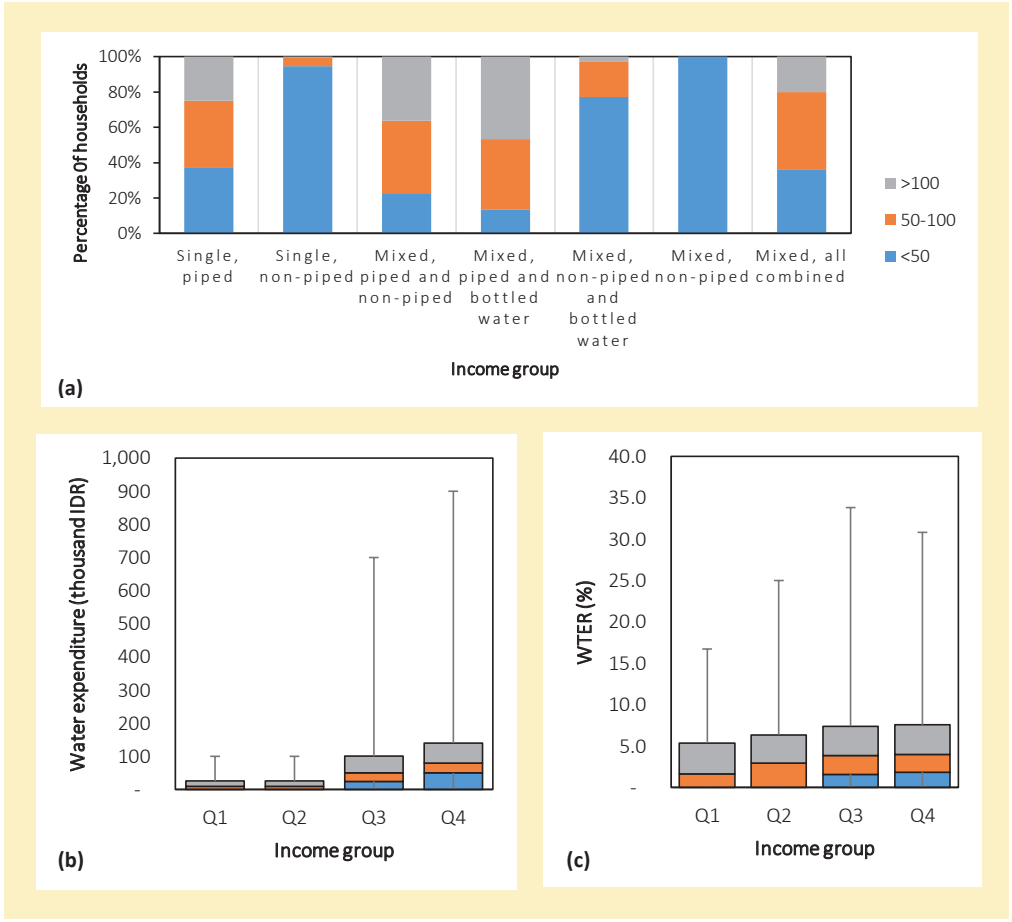
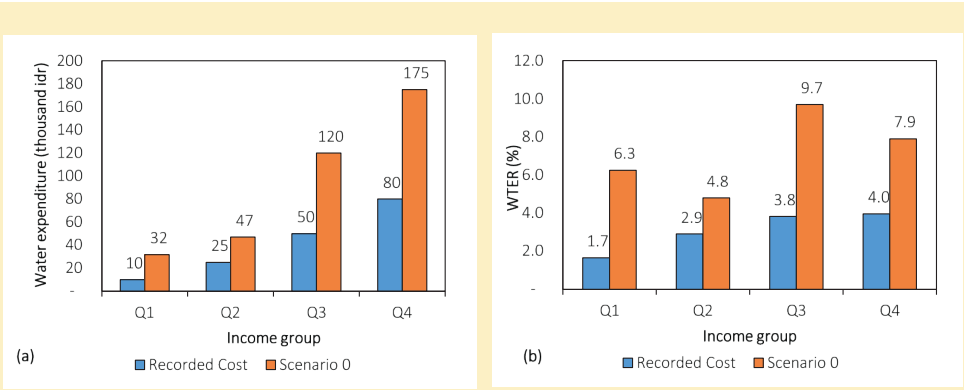
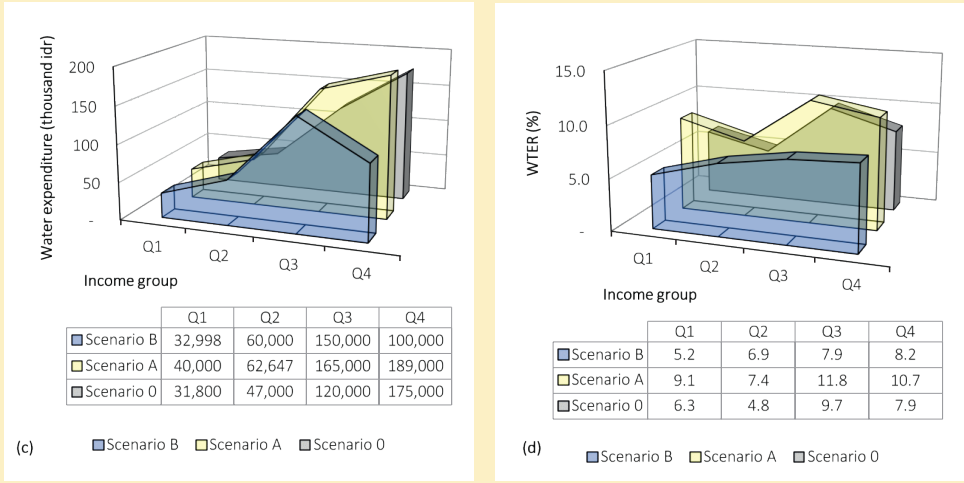


Figure 5.3 Section (a) shows the distribution percentage of household water expenditure based on the type of water access (in thousand IDR). Meanwhile, section (b) shows the Kruskal-Wallis test boxplot of water expenditure among income groups (in IDR) and section (c) shows the Kruskal-Wallis test boxplot of water expenditure expressed as a percentage of total expenditure (WTER) among income groups

Groundwater users in Q1 and Q2 incurred the amortized cost of dug well construction, while groundwater users in Q3 and Q4 incurred the: (1) amortized cost

of borehole set construction, (2) amortized cost of overhead storage facility construction, and (3) variable cost of pumping. The households in all income groups that did not buy bottled water incurred the fixed cost of boiling water. The cost estimates for the mitigation behaviours were presented earlier in Table 5.2.





	Q1	Q2	Q3	Q4
Scenario B	32,998	60,000	150,000	100,000
Scenario A	40,000	62,647	165,000	189,000
Scenario 0	31,800	47,000	120,000	175,000

	Q1	Q2	Q3	Q4
Scenario B	5.2	6.9	7.9	8.2
Scenario A	9.1	7.4	11.8	10.7
Scenario 0	6.3	4.8	9.7	7.9

Figure 5.4 Section (a) and (b) shows the median values of household water expenditure (in IDR) and household water expenditure expressed as a percentage of total expenditure or WTER (in %) before (recorded cost) and after mitigation costs are incorporated (Scenario 0). Meanwhile, section (c) and (d) shows the scenario outcomes showing the median value of household water expenditure (in IDR) based on income group and the median value of WTER (in %) based on income group.

We then compared household water expenditures before and after mitigation costs were incorporated. The median monthly water expenditure increased as income increased (see Figure 5.4(a)). Q1 households experienced a 3.2-fold increase in water expenditure when the mitigation costs of groundwater extraction and boiling were taken into account, whereas the water expenditures of Q2, Q3, and Q4 households roughly doubled when the mitigation costs were incorporated. Similarly,

Q1 also experienced the highest increase in WTER when the mitigation costs were incorporated: 3.7-times (see Figure 5.4(b)); Q2, Q3, and Q4 households experienced 1.7-times, 2.6-times, and 2-times increases of WTER, respectively, when mitigation costs were included (see Figure 5.4(b)). The water expenditure and WTER that include the mitigation costs represent Scenario 0 in our analysis.

Next, we developed two alternative sets of scenarios: A and B. In scenario A, there is universal access to piped water while households sustain groundwater extraction. In scenario B, there is universal access to piped water, but the households do not extract groundwater. By examining these scenarios, we expected to understand how changes in the level of piped water access and mitigation behaviours affect water expenditure. Figure 5.4(c) shows that in scenario A, water expenditure in Q1, Q2, and Q3 households rose on average 1.3-times from the base expenditure, while the households in Q4 experienced almost no increase in water expenditure. In scenario B, the costs of groundwater extraction were avoided. The water expenditure for Q4 was reduced significantly in this scenario to almost half of that experienced in scenario 0. In contrast, the water expenditure of Q1 households in scenario B was equivalent to that observed in scenario 0, and Q2 and Q3 households experienced a slight increase (1.3 times) in their water expenditure compared with that observed in scenario 0. Meanwhile, Q4 experienced a significant decrease of water expenditure: 0.57-times compared to that observed in scenario 0.

In the case of WTER, in scenario A, the Q1 and Q4 households experienced on average a 1.4-fold increase in WTER compared with their base water expenditure (scenario 0; see Figure 5.4(d)). In scenario B, in which all households used piped water and abandoned groundwater, Q1 households (5.2%) and Q2 households (6.9%) experienced lower WTER than Q3 households (7.9%) and Q4 households (8.2%). For Q1 and Q3 households, these percentages were lower compared than those predicted in the respective base scenarios. In contrast, the Q2 households experienced a 1.4-fold increase in WTER compared with that experienced in the base scenario but a reduction compared with the WTER in scenario A. For the Q4 households, when access was granted to piped water and groundwater extraction was abandoned (scenario B), the WTER was almost equivalent to that observed in scenario 0.

On average, the results suggest that having access to piped water while sustaining groundwater extraction would increase the household water expenditure and lower household affordability of water for all households except Q4, which would experience almost no increase in water expenditure. This is perhaps due to the already high coverage of piped water in Q4. If groundwater extraction practices are abandoned, as assumed in Scenario B, having piped water access would still increase the amount of household water expenditure on Q1, Q2, and Q3, but the increase would be much less than that observed with Scenario A. Q4 households, however, experienced a significant reduction of water expenditure since these groups mostly used costly borehole. Nevertheless, when households all have access to piped water while avoiding groundwater extraction, WTER in all income groups in all three scenarios still exceeded the affordability limit

"On average, the results suggest that having access to piped water while sustaining groundwater extraction would increase the household water expenditure and lower household affordability of water"

of four per cent determined by the Regulation of Minister of Internal Affairs Number 23/2006.

5.5 Discussion

This paper examines the issue of equity, which we operationalized as not only the level of access but also with regards to water-related costs differentiated among households in different income groups in Central Cikapundung Basin, Bandung City, Indonesia.

5.5.1 Equity of access

Our findings first suggest that a glaring inequity of access to water, particularly access to piped water, persists among households with different income levels. In the Central Cikapundung Basin, lower income households have less coverage of piped water. Globally, access to a household network connection has been strongly differentiated economically (UNICEF & WHO, 2015). In Indonesia, a similar gap has been found in Jakarta (Bakker et al., 2008), Nairobi (Mudege & Zulu, 2011), and Cape Town (Smith & Hanson, 2003). There is some discussion as to why the poor are persistently excluded from piped water service. In the case of Jakarta, for example, Bakker et al. (2008) identified several disincentives related to institutional factors for the water supply utility to connect poor households and/or for poor households to connect to the network. In Bandung, the low level coverage of piped water service among households in the lowest income bracket may occur because the piped network do not reach the area in which they are residing, the connection charges are unaffordable, and/or a the service quality is perceived as poor.

However, households that have access to certain water sources and use it for bathing and other basic hygiene purposes do not always use such sources for drinking. Thus, this distinguishes “drinking water”, a source of water that households deem safe enough to consume, from merely “clean water”, a source of water used for bathing and domestic purposes but not for drinking unless it is treated beforehand. The survey also demonstrates the popularity of bottled water across all income groups. The National Statistical Agency reported an almost two-fold increase in bottled water usage from 10.35% in 2009 to 19.37% in 2010 (BAPPENAS, 2012). Ferrier (2001) had predicted Asia-Pacific, including Indonesia, as the most promising market for the bottled water industry, with an annual consumption growth of 15%.[2] The survey also showed that the usage rate of bottled water was higher in households with higher income, whereas many households in the lowest income level obtained their drinking source from groundwater and/or springs. This emphasizes the importance of local water source protection and conservation to maintain water quality as a public health defence measure. This is because the poor are more likely to rely on single non-piped sources, unlike higher income households, which are more likely to combine bottled water and other sources for non-drinking purposes. The poor may no have means to reduce the risk of water-borne illness posed by poor drinking water through regular purchase of high quality bottled water.

5.5.2 Equity of cost burden of water

In regard to water expenditure, the households that pay more for water, both in absolute values and in proportion to total expenditure, are those with a higher

income level and access to piped water. The multiple regression analysis also showed that water expenditure is positively affected by total monthly expenditure, one of the indicators for wealth. Contrary to popular belief that the poor pay more for water, the Q1 households did not pay the most money for water in Central Cikapundung. In contrast, in Manila, for example, poor households pay as much for water as much as they pay for rent (McIntosh, 2003). This exceptionally high cost for water is driven by the reliance on water vendors, who price water at 4 to 30 times the price of public piped water service (Wutich et al., 2016). Water vendors do not provide water service in our case study area; thus, the low income households rely on groundwater and spring instead, avoiding the cost of water trading. The water expenditure comparison among income groups may yield different results if similar studies are conducted in areas where water vending is a common practice.

In our study, households that used both piped water and bottled water paid the highest amount of money for water. The multiple regression analysis demonstrated that having access to piped water and purchasing bottled water explains most of the variance in water expenditure. As much as 19.3 % of households in the survey reported not paying a single Rupiah for water. These households lacked access to piped water and did not buy bottled water. Therefore, we interpret the water expenditure recorded in the survey to represent only the "direct" expenditure, which is the amount of money spent in direct transaction to obtain water (i.e. water bill or bottled water sale). This suggests that households ignore or do not realize the costs that may be incurred to obtain water other than that obtained from piped water and bottled water.

"Households bear the "hidden" mitigation costs of water extraction and boiling that are due to the poor service quality of the piped water"

Households bear the "hidden" mitigation costs of water extraction and boiling that are due to the poor service quality of the piped water. We estimate that these water extraction and treatment activities may results in costs incurred by households that are two to three times higher than the recorded water expenditure. To date, Indonesia has not considered this hidden cost burden in its water sector policy. The only regulatory instrument limiting the cost burden related to water is the four-percent limit of water utility tariffs imposed in the Regulation of Minister of Internal Affairs Number 23/2006. The real cost of water born by households may be higher than that. This is particularly an issue for low income households.

5.5.3 The effect of piped water expansion and mitigation behaviour on water expenditure

The scenarios we developed show the effect of the expansion of piped water access and mitigation behaviour, from which we made the following inferences.
First, installing new connections of piped water while sustaining groundwater extraction in general will reduce the economic accessibility of water. *Second*, having access to piped water while abandoning groundwater extraction will return water expenditure almost to the base water expenditure for households with the lowest income, the costs of using piped water are similar to the costs of groundwater extraction. *Third*, in terms of water expenditure, households with the highest income level will benefit the most from piped water service improvement. This is because of these households chose a

more costly extraction method in our scenario. However, expanding access to piped water and discouraging groundwater extraction may most increase the affordability of water supply for the lowest income group. If one uses the 4 percent Indonesian water affordability limit or the 'five-per cent rule', accessing piped water is still considered unaffordable for households in all income group. However, McPhail (1993) suggests that the households are actually willing and able to pay seven to ten per cent of their total household expenditure for individual water connections.

The water expenditures in our results are underestimated since we excluded the time-cost of boiling and/or filtering water as well as the transaction costs to access public piped water sources (Bakker et al., 2008; Nganyanyuka et al., 2014). Moreover, the outcomes of our scenarios were also based on the assumption that all households are willing to embrace new piped water connections, which is often not the case in Indonesian cities. A previous study in Bandung demonstrated that the rejection of households towards piped water service stems from the perceived risks relating to the exposure of households to poor water quality and economic losses resulting from interruptions to water supply (Nastiti et al., 2017). To further promote acceptance of piped water, trust in public water supplier must be improved by directing efforts to the improvement of water quality and continuity of piped water supply. Our scenarios were not optimistic about households dropping mitigation strategies related to buying bottled water. The vast use and the ease of bottled water along with many technical and administrative difficulties associated with improving the quality of piped water service means there is little pressure on water supply providers to achieve potable water quality of piped water service in the near future.

5.6 Conclusions and recommendations

In conclusion, there is inequity in the type of access to water among households of different economic statuses. Expanding access to piped water indeed closes this equity gap, but special attention must be paid to make piped water connections affordable for the lowest income population. High water cost burden is also experienced by lower and higher income households, with access to piped water and bottled water as the most significant predictors for the variance of water expenditure. Mitigation costs resulting from the sustained use of groundwater are hidden but raise the total costs of water two- to three-fold. By discouraging the use of groundwater when piped water connection is available, hidden costs related to water can be directed towards public service for service expansion and service quality development while improving the ecological function of groundwater.

"Mitigation costs resulting from the sustained use of groundwater are hidden but raise the total costs of water two- to three-fold."

Finally, we also strongly recommend future studies to develop cost-benefit analysis in assessing the economic impacts of poor service quality of water supply in developing countries that take into account mitigation costs. At present, the benefit of providing safe and adequate water supply are widely discussed in the context of averted healthcare costs (Hutton, 2013). We encourage a full consideration of all aspects of domestic water supply, which includes not only 'drinking water' but also water required in large quantity for all basic domestic purposes, such as bathing and washing. As Goff & Crow (2014) mention, "…the focus on drinking water has fostered a single-minded concern for the health aspects of water, and… fails to measure other important characteristics for domestic water. These include water

collection time, reliability, social arrangements, and cost" (p.161). Therefore, it is important to include other costs that are not related to health outcomes in cost-benefit analyses, i.e. mitigation costs to cope with poor quantity and continuity of water sources. A full grasp of mitigation costs will be particularly useful in understanding equity in the water cost burden and fostering investment decisions in areas with low piped water coverage.

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Notes:

1. The concept of improved water sources centres on the issue of water quality, hence, drinking water. The JMP uses improved water source as a proxy for measuring "sustainable access to safe drinking water" of Target 7C MDGs. Households using bottled water for drinking are considered to have "improved source" when they use a type of improved source for cooking and other domestic needs.
2. The control over the quality of bottled water in registered companies is relatively straightforward, but it should be noted that there is also another type of bottled water in Indonesia: refillable bottled water sold by small kiosks with minimum treatment. The regulations of this product require special attention as they are more informal, and many are unregistered in cities' health offices.
3. The Regional Minimum Salary is a minimum standard for industries to provide monthly salary to the unmarried labourers. It is proposed by a regional-level committee consists of representatives of bureaucrats, academician, labours, and industries; it may be revised each year and is stipulated through a provincial-level regulation.

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Chapter 6

Cultivating innovation and equity in co-production of commercialized spring water in peri-urban Bandung, Indonesia

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6.1 Abstract

This paper examines a co-production arrangement between private actors, households, and community actors occurring within the framework of scheme of commercialised spring water in peri-urban Bandung, Indonesia. We argue that the provision of spring water in Ujungberung District is a form of co-production, characterised by: (1) any one, or the elements, of the service production process being shared; (2) the presence of a fundamental shift in the balance of power between the primary producers and users/communities, and (3) the existence of mutual support and relationship networks, rather than a clearly defined delineation between providers and clients. Actor contributions defined as inputs along the value chain of spring water production were examined. We describe interactions between local private actors and community members in planning, service delivery, and conflict management with respect to disruption of water supplies, free-riding behaviour, and the geographical distribution of services. This paper identifies several institutional innovations that may yield a safer and more affordable water supply and nurture equity in the sense of: (1) improved access to water for the previously unserved people by piped water and boreholes; (2) the opportunity to negotiate from below; and (3) transparency and accountability.

Keywords: *Co-production, equity, innovation, water commercialisation, Indonesia*

6.2 Introduction

"(The previous owners of the springs) sell their land and their springs to the water entrepreneurs so these entrepreneurs can bring water to us… What's the use if spring water cannot flow to our houses? It will benefit no one if the water stays uphill". This statement, by a citizen of Ujungberung District, Bandung, Indonesia, illustrates how the locals see spring water commercialisation as a means of bringing clean water to people's homes. Transporting water to human settlements has been a challenge since the early history of urban development. In the postcolonial area of the South, population growth at the outskirts of cities is occurring faster than in the urban centres, yet infrastructure development is inconsistent (Firman, 2004; Norstrom, 2007). Development of centralised water infrastructure has focused mainly on urban centres and has not reached the sprawling areas at the fringes of cities. Peri-urban citizens remain underserved, if at all, since neither networked state utilities nor large-scale private water companies are able (or, often, willing) to serve these areas effectively (Allen et al., 2006).

The lack of a state-led service for water supply provides market opportunities for private actors to fill the gap of water provision. Local private actors, rather than state actors, serve as the main provider of basic services in many of the areas underserved by state-owned water companies (Venkatachalam, 2014). This paper examines the provision of commercialised spring water in Ujungberung District, Bandung. In the management practice of commercialised natural resources, commercial principles (such as efficiency and profit-maximisation) are introduced (Sangameswaran, 2009). What's more, in the wake of its inception in the early 2000s, the commercialisation of spring water in Ujungberung District has also been followed by interactions between local private actors, community actors, and households. These interactions are an example of co-production. Scholars traditionally define co-production as "the joint production of public service between citizens and the state, with any one or the elements of the production process being shared" (Allen et al., 2006: 340). The co-production concept is rarely applied during the characterisation of active engagements between non-state actors. Yet, the notion of co-production fundamentally reflects the relationship between service providers and service users in which users play an active role in improving the service they receive.

"The notion of co-production fundamentally reflects the relationship between service providers and service users in which users play an active role in improving the service they receive."

This paper presents a case study of a private and citizen co-production process occurring within the framework of a spring water commercialization scheme. We specifically address the following questions. Firstly, how is spring water service provision co-produced in Ujungberung District? We investigate the engagement of citizens, not merely as users, but also as (co)producers along the value chain of the production of drinking water, a range of processes in which they add value to raw water sources through abstraction, transportation, treatment, and distribution. The added value in these processes lies in the sense of the usability of spring water for the citizens in Ujungberung District; without these processes, people will not be able to enjoy the benefit of spring water daily. Secondly, does the co-production contribute to the improvement of service delivery? Who has the most convenient access to water, socially and geographically? These questions address whether

innovations and equitable access along service provision are produced as results of the co-production processes.

The remainder of this paper is structured as follows. First, we briefly review the literature over private actors' involvement in the drinking water sector, along with definitions and experiences of co-production arrangements, before describing the method of our study and the case study area. Then we describe aspects of co-production within the commercialised spring water value chain and address the question whether such processes contribute to innovation and equity. Last, we discuss our results and present conclusions. We demonstrate that commercialisation of spring water serves as a starting point for the establishment of a co-production arrangement between private actors, households, and community actors. Several institutional innovations that may yield a better service and nurture equity are highlighted.

6.3 Participation of the private sector and co-production in service delivery of the water supply

The involvement of private actors in water supply has been debated for a long time. Attempts to involve private actors in urban water supply network investments marked a departure in the late 1980s (Prasad, 2006). International financial institutions and donor agencies expected private actors to provide a more efficient service and a better form of governance compared to 'low-level equilibrium' services provided by the state, in which low efficiency leads to low-quality service (Prasad, 2006). Even so, private actors' participation is often viewed to result in a violation of human right to water as these actors operate on the basis of full-cost recovery through user fees and, further, profit-making (Budds and McGranahan, 2003). For example, private-sector participation in water supply service of the capital city of Indonesia, Jakarta, may reduce water affordability as a consequence of tariff increase (Bakker et al., 2008). The poor, who cannot pay for water, are further excluded from basic water services. For these underserved poor, small-scale private providers (SSIPs) increasingly assume a role as the dominant providers. This type of water vending accounts for a large proportion of total water revenues and is no longer a fringe activity (Gulyani et al., 2005).

In many private-led water provision systems, both provided by large private corporations and SSIPs, citizens have traditionally been perceived as merely consumers at the receiving end of the water supply system. However, studies have documented that citizens occasionally contribute to the provision of water services through engagement in certain strategies that maintain the expected level of service (Allen et al., 2006; Mitlin, 2008). These strategies often occur jointly with the activities of private actors. For example, MacCarthy et al. (2013) reported the existence of 'self-supply' markets in which the local private sector provides drilling and pumping technologies to enable households to access shallow groundwater. The 'citizens as service providers' complement traditional water service providers. Citizens who play significant roles in service provision transform the traditional model of service production into one of co-production (Pestoff, 2006).

To guide the analysis, full understanding of co-production is necessary. The theoretical notion of co-production has been interpreted widely. In literature on new public management, the conceptions of co-production often lie within the scope of

state and citizen collaborations (Brudney and England, 1983; Pestoff, 2006). The participation of citizens in these collaborations is voluntary in nature, rather than contracted (Brudney and England, 1983; Isham and Kähkönen, 1998). These voluntary acts are the distinct features of co-production that lead to the improvement of service quality and/or quantity. Ahlers et al. (2014) describe co-production as a process where hybrid service provision modalities produce new meaning. Ostrom (1996: 1073) defines co-production as "the process through which inputs used to provide a good or service are contributed by individuals who are not in the same organisation". Ostrom's definition is used to guide the analysis in this study, even though in her definition the primary producer is usually a governmental agency. Alford (2014) also advocates a deeper analysis beyond the simple attribution of co-producers, to include what they do for, and gain from the co-production process. This definition allows further analysis of the capacity and motivations of each actor.

Early definitions of co-production restricted the definition of co-producers to consumers, and thus disseminated the notion of 'consumer producer' (Joshi and Moore, 2004). Consumers (partly) provide their own services, contributing to the service they receive (Pestoff et al., 2006). The involvement of a diverse range of organisations undertaking social activities aimed at raising the quality of public services has also been recorded; thus co-producers may also be volunteers and community members (Bovaird, 2007). Pestoff and Brandsen (2010) refer to these actors as the 'third sector' in public service delivery, which includes the voluntary sector, the (private) non-profit sector, and civil society. Parks et al. (1981: 1002) suggest that collaborations "may occur directly through coordinated efforts in the same production process, or indirectly through independent, yet related efforts". Our study emphasises the coordinated efforts of private actors and the third sector in the co-production of services, and includes the separate contributions of households to service quality improvement.

Pestoff and Brandsen (2010) have discussed the advantages of co-production of service delivery compared to their traditional counterparts in which citizens merely function as users. This article focuses on the potential contributions of co-production towards innovation and equity. Pestoff and Brandsen (2010: 228) define innovation as "the ability to renew the collective structure of service provision, whether it be in terms of skills, activities or even the underlying paradigm", or concerning "the quality of the service itself".

In the water supply sector, equity of access to water is entered in the framework of Sustainable Development Goals (SDGs) (UN–Water et al., 2015). The United Nations (2007) also emphasises that poor households should not be burdened by higher water expenditure than the rich. SDGs also require to "allow the poorest and most vulnerable to negotiate from below" and demand more transparency and accountability in its conceptions of equity (UN-Water et al., 2015: 5). McMillan et al. (2014) examine technical water committees in Venezuela with respect to co-production of water service delivery. Reduction of asymmetry in the availability of information and improved accountability are the main advantages of this arrangement. Jakobsen and Andersen (2013) further argue that the main constraint suffered by disadvantaged citizens during co-production is their lack of knowledge (and materials). Thus, evidence that the Venezuelan water committees reduce knowledge barriers suggests that co-production also contributes to reduced inequity. Two studies in South America, McMillan et al. (2014) and Llano-Arias (2015),

discuss cases of state and citizen co-production. However, evidence elucidating the contributions of private/citizen co-production towards equity remains scarce. We analysed the case of a commercialised spring water source supplied by local, small-scale private actors, and investigated any potential resulting institutional innovations and whether these arrangements come at a cost to equity.

6.4 The case study of Ujungberung District, Bandung, Indonesia

6.4.1 Data collection

To understand how water is co-produced, we conducted semi-structured interviews with local private actors, community actors, and households (see Table 6.1). We recruited participants mainly based on information provided by a key informant and recommendations made by the interviewees. There is limited documentation on the occurrence of non-state-led water provision in Ujungberung District. Thus, we first distinguished different types of water sources used among households in Ujungberung District, and identified relevant individuals/groups (and their related activities) within the chain of water service production: from usage, distribution, treatment, transportation, and source extraction.

Table 6.1 Interviewees and interview questions.

Interviewees	Interview topics
Three spring owners and/or operators; Two water tanker truck owners who buy water from spring owners and sell it to commercial clients, e.g. refill water kiosks. Five refill water kiosks that own and operate small bottled water facilities. They sell pre-treated water in refillable 19 litre bottles. Two pushcart vendors that sell water door to door to households.	Business establishment, raw water sources, operation and maintenance (O&M) practices, costs, volume of water sales, water pricing, labour arrangements, quality assurance, business strategy, free-riding behaviours, and relationships with other actors.
Three senior community members and local chiefs[1] who have gained experience with both state and co-production regimes of water provision since the 1980s.	Experiences before and after both commercialisation of spring water and co-production took place, (before and after receiving?) information on the water allocation agreement between entrepreneurs and the community.
Two volunteer water stewards, who contribute to the operation, maintenance, monitoring, and allocation of water delivered by spring-water entrepreneurs to a communal tank. A water watcher who is responsible for the monitoring of the spring water distribution network.	O&M of distribution network of spring water.
Two households that have individual connections to spring water sources.	Household economy, the maintenance of service levels, free-riding behaviour, and attitude towards commercialising of spring water.
A supervisor from the municipal piped water company (MWC).	O&M of the treatment plant and distribution network.

To further facilitate understanding of user's experiences with different modes of provision, additional semi-structured interviews were conducted with 70 household participants in Ujungberung District. We collected data on types of access, household strategies, the perception towards dimensions of access (physical

access, quality, continuity, quantity, and affordability of water), and expenditure for water. All interviews in this study were recorded on a digital voice recorder and transcribed in the original language: a mix between Bahasa and Sundanese.

6.4.2 Data analysis

We conducted a content analysis of all interview transcripts, codified key terms, and extracted emerging themes (Elo and Kyngäs, 2008; Otero et al., 2011). To understand how water is produced, we followed Ostrom's (1996) concept of co-production, i.e. the process by which individuals from different organisations contribute inputs to the water supply service provision. We examined the input contributions of water actors along the value chains of water production. We operationalised input as production factors that are used to deliver water supply to consumers: human labour, technology, land, and financial capitals.

Next, we scrutinised how we could properly evaluate the contribution of co-production to innovation. As discussed in Nganyanyuka et al. (2014), water supply has dimensions of access that relate not only to the physical access, but also to water quality, water quantity, water continuity, and affordability. Following Pestoff and Brandsen (2010), we conceived of innovation as a renewed structure in the provision of water service delivery that leads to an improvement in one or more dimensions of access in water service delivery. Assessing the contributions of a renewed provision structure was done by: (1) comparing different modes of provision, and (2) revisiting the characteristics of past water services and contrasting those with present circumstances. We identified both actors and their activities which have contributed significantly to changes in physical access, quality and affordability of water provision.

Next, we examine the change in access to water and operationalised the concept of equity of Jakobsen and Andersen (2013) to understand how co-production may affect equity of water supply provision. We also sought to reveal the effect of co-production on accountability, examined available evidence of negotiations at the grass-roots level and determined the presence of any knowledge barrier that could impact access to water services. We obtained insights from community members and household users. Additionally, we investigated geographical differences in access to spring water services.

6.4.3 Water provision in Ujungberung District, Bandung, Indonesia

Bandung, the capital city of West Java Province, Indonesia, consists of 32 districts and is inhabited by a population of 2.5 million. Roughly a third of the water supplied in Bandung City is provided by the Municipal Water Company (MWC) (Yamani, 2011). We selected one of the eastern districts, Ujungberung District, as the central research area of this analysis owing to the presence of commercialising of spring water (see Figure 6.1). This district is a rural-urban fringe region and consists of 18,467 households (Statistical Office of Bandung City, 2015). The elevated part of this district sits adjacent to the neighbouring Bandung Regency, which is mostly unserved by the MWC water service.

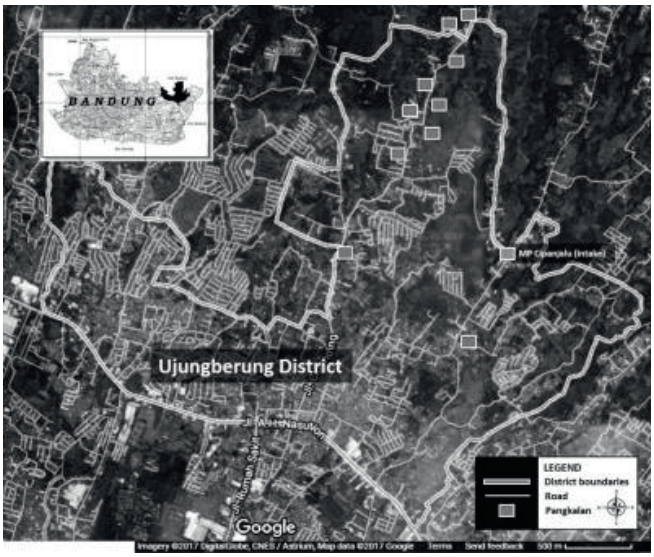

Figure 6.1 Map of Ujungberung District (from Google Earth© 2017). Note: The district is well-known for commercialising of spring water. Spring water sales take place mainly in pangkalan shown by red rectangles.

The MWC of Bandung City currently serves only 6.7% of the district's population through household connections (Government of Bandung City, 2014). The water is supplied from a water treatment and distribution facility, Mini Plant (MP) Cipanjalu, which was built in 2004. Meanwhile, most of the district's population are served by self-service (i.e. groundwater and surface water sources, including spring water) or through commercial means (i.e. sale of both bottled water and spring water by local entrepreneurs). More than 77% of households in Ujungberung District rely heavily on groundwater extracted through boreholes or dug wells (Bandung City Health Office, 2013). Spring water had also previously been utilised, but not to the degree that it is being extracted at present. Formerly, spring water users obtained their water on the basis of neighbourly relations: spring water was gifted and collected in containers. At present, spring water, well-known as 'mountain water', is sold extensively within and outside the district.

6.5 The value-chain of commercialised spring water

Commercialised spring water first entered the market in the early 2000s when some landlords sold parcels of land which included springs to local water entrepreneurs. We examine the value chain of commercialised spring water from source to consumer and identified three types of actors and their roles in the value chain of spring water: local private actors, community actors and committees, and household users (see Figure 6.2).

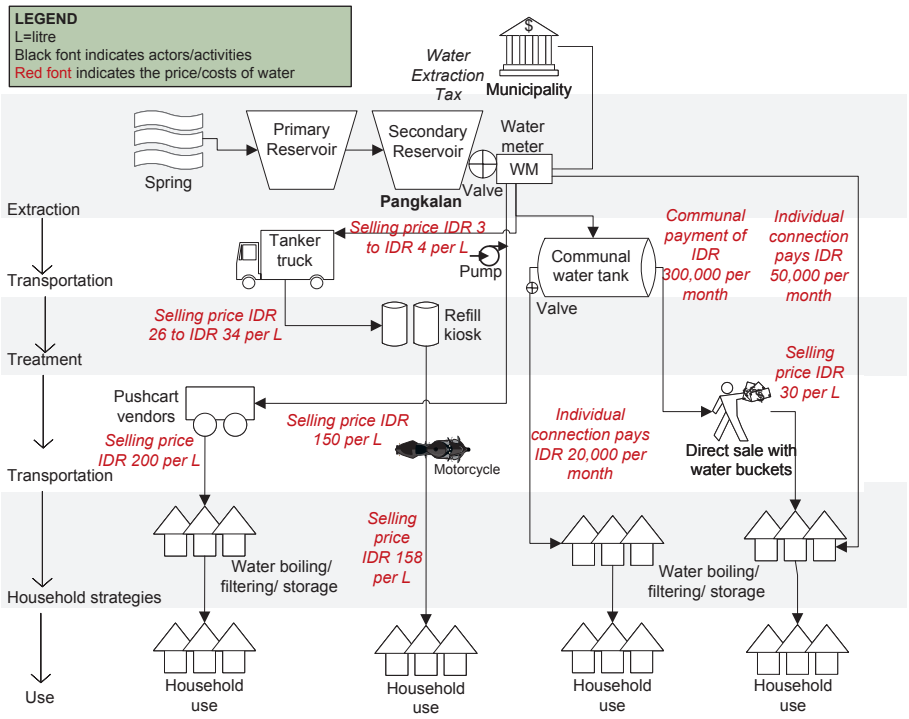

Figure 6.2 Value chains of commercialised spring water in Ujungberung District.

Water extracted at the springs is transported to refill kiosks by tanker trucks. The water is then treated, packed, and distributed by refill kiosks to household users as readily available drinking water. Water from springs is also distributed to houses through pushcarts, hoses or buckets from communal water tanks. Prior to use, households may also adopt several strategies to improve quality or ensure availability of spring water from vendors or communal water tank (i.e. through boiling and filtering water followed by storage). Co-production processes particularly occur in the distribution of water until it reaches household users.

6.5.1 Water extraction

To acquire the freshwater in springs, local entrepreneurs bought land parcels from former landlords. An entrepreneur invested roughly IDR 100,000,000 (USD 8475) to install one typical extraction facility for spring water, i.e. spring protection structures, primary reservoirs, gravity-led piping systems, secondary concrete reservoirs, and electrical pumps. As shown in Figure 6.2 above, the natural spring is protected by concrete structures which also facilitate water flow to a primary reservoir. Water is delivered from the primary reservoir through piping systems, partly underground and partly on the surface, to a station in which a secondary reservoir is located. Stations in which water sales activities take place are locally known as pangkalan. We identified ten pangkalan in our study area, including those located in the administrative territory of the neighbouring regency.

6.5.2 "Raw" water transportation from springs/pangkalan to refill kiosks

Spring owners, or pangkalan owners, sell water to their primary customers, tanker trucks owned and operated by individuals who serve as the primary transporters of spring water to commercial clients (i.e. refill kiosks) and industrial clients (e.g. manufacturing or beverage industries that require bulk water supply for their production processes). Electrical pumps are used to draw water from secondary reservoirs into tanker trucks that have a capacity of 3000 to 5000 litres (see Figure 6.3 (a)). Additionally, pangkalan owners commonly provide their own tanker trucks. The selling price of water from tanker truck owners to refill kiosk owners depends on the distances over which the water is transported. Prices range between IDR 130,000 (USD11.00) and IDR 170,000 (USD14.5) per 5000 litres (or IDR 26 to 34 per litre). The price is based on fuel costs, and the salary of truck drivers and their assistants. Some kiosk owners provide their own tanker trucks to buy raw water supply from pangkalan.

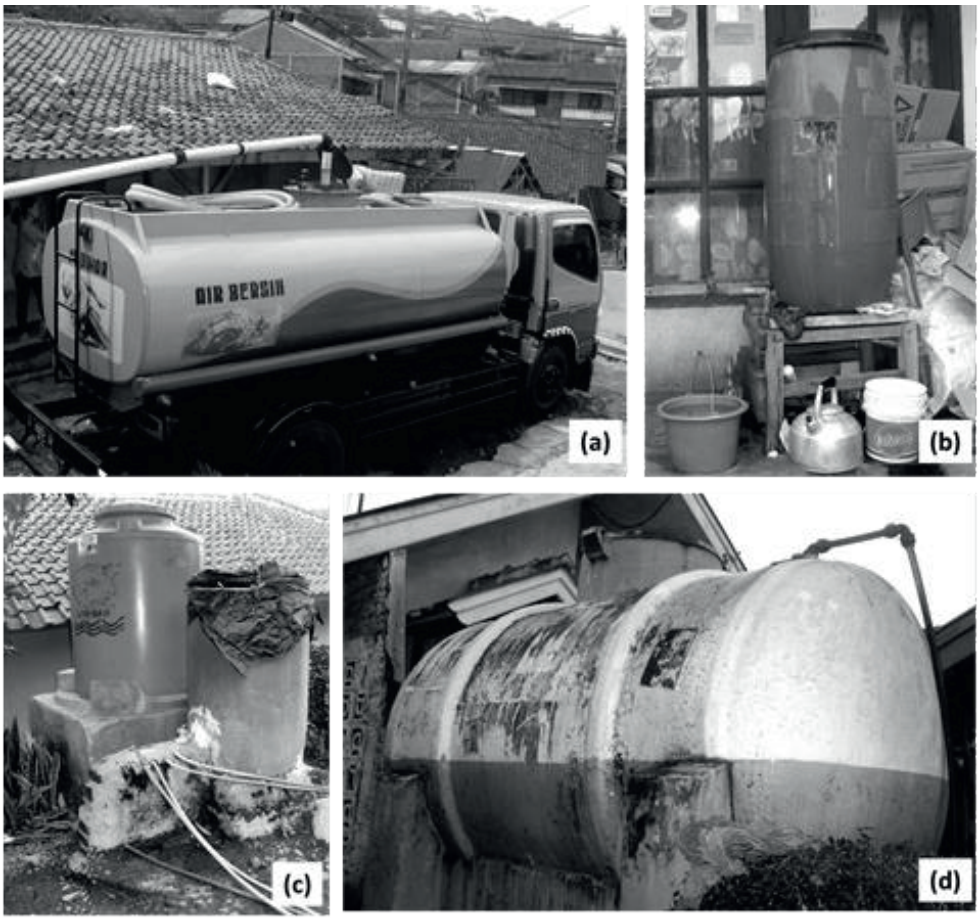

Figure 6.3 (a) A truck is filling its tank with spring water in a pangkalan; (b) household water storage; (c) and (d) two examples of communal water tank.

6.5.3 Water treatment by refill kiosks

Refill kiosks apply industrial processes that treat raw water to produce potable water, which they subsequently sell directly to consumers in refillable bottles (Ministry of Industrial and Trade, 2004). Tanker trucks deliver raw water three times a week to the refill kiosks. Water is stored until it is treated to provide drinking water. Refill kiosk owners buy a set of water treatment units that typically apply filtration, and ozone purification processes. The cost of a single unit ranges from IDR 21,000,000 (USD 1780) to IDR 35,000,000 (USD 2966). Filtered and disinfected water is then bottled using 19-litre plastic containers. Kiosk owners sold water to consumers for a price of IDR 3000 (USD 0.25) per container (or IDR 158 per litre).

6.5.4 Water distribution to household users

Spring water reached users via several different pathways: pushcart vendors, refill kiosks, directly from pangkalan through individual networks, or indirectly via communal tanks. Pushcart vendors buy water from pangkalan at a price of IDR 1500 (USD 0.13) per 10 litres (or IDR 150 per litre) using pickup trucks, each with a capacity of 1000 litres. These vendors mainly sell water to regular household clients at a price of IDR 2000 (USD 0.17) per 10 litres (or IDR 200 per litre). Water vendors own multiple units of pushcarts and hire other individuals to sell water door to door. However, water delivered by these vendors is not potable water. Refill water kiosks deliver to households water that can be supposedly consumed directly without treatment, mainly by motorcycles.

Spring water is also distributed through individual and communal networks. We focused on pangkalan that allow local communities to tap from the reservoir, either directly to premises using rubber hoses or indirectly via communal water tanks. It is in these situations where co-production, characterised by the voluntary efforts of community actors and users to enhance the service quality of water provision, occurs. Households situated near pangkalan have negotiated a monthly price of IDR 50,000 (USD 4.3) for individual connections that provide two or three hours of water supply daily. A pangkalan owner explained the arrangement, "that house only receives water in the evening, we cut off the supply in the morning. That's the deal we talked about, no written agreements". Under this arrangement, individual households are responsible for the setting up and maintenance of their own supply network and storage tanks.

If a communal supply is arranged, pangkalan owners and community actors initially come to an informal agreement. This agreement allows the pangkalan owners to sell water outside Ujungberung District only if they also provide water to local communities. Pangkalan owners initiate supply to local communities after supply trucks stop operating for the day. Further, local communities are responsible for the distribution of water from pangkalan to the point of use. Different neighbourhood communities acquire spring water from pangkalan in turn for three hours per day. Personnel volunteered as water stewards are responsible for: (1) setting up the distribution and storage system, (2) negotiating the schedule for distribution within neighbourhoods, (3) operating and maintaining the water delivery system, (4) collecting payments, and (5) recording complaints. Spring water from pangkalan is distributed through rubber hoses to iron water tanks with a capacity of 3000 litres. Water is further distributed from communal tanks to dwellings through individual connections (see Figure 6.3 (c) and (d)). Additionally, water is sold directly from

communal tanks for IDR 500 or USD 0.04 per 3.3 litre bucket. When the water supply is maintained according to the agreed schedule of three hours per day, households with individual connections pay IDR 20,000 every 10th day of the month (USD 1.7). However, these households can pay less (IDR 15,000 or USD1.3) if the supply of water is interrupted. The continuity-based price was considered to be a strong advantage of this arrangement in comparison with the piped water service provided by the MWC. Fees are collected by water stewards and IDR 300,000 (USD 25.4) of the collected fees is paid to pangkalan owners as a standard monthly payment. Any remaining fees are used to maintain the tanks and distribution network.

6.5.5 Household strategies and water usage

Households use water that is delivered either by pushcart vendors or through a communal or individual network for drinking, bathing, washing, and cleaning. To improve the quality of water, households boil spring water obtained from communal tanks, individual networks, and pushcart vendors prior to drinking. Households adopt water storage practices to mitigate for the unreliable water supply (see Figure 6.3(b)). These strategies are individual household's contribution to the co-production process for the provision of water supply.

6.6 The contributions of co-production to innovation and equity in water service provision

In this section, we discuss how collaborations between private, community, and household actors have contributed towards innovations in service provision and equitable access to water in Ujungberung District. Users' experiences of water delivered were analysed to determine any change in the dimensions of access resulting from the co-production process. We interviewed 70 householders with an average income of IDR 3,000,000 (the Minimum Regional Salary of Bandung City 2014 is IDR 2,000,000); 34% of householders interviewed used spring water and only 11% enjoyed a piped water service daily. The others rely on groundwater extracted from boreholes with pumps or dug wells. However, the use of multiple water sources is a common practice: 67% of households combine different water sources to be used daily. Some households whose main water supply consisted of shared or individual access to spring water previously relied on an unimproved source which is unreliable during the dry season, i.e. water vendors or dug wells. In general, the joint activities of spring entrepreneurs and community actors have led to an increase in diversity of water sources in the district;56 out of the 70 households which we have interviewed are unserved by 'improved' water sources (i.e. piped water and boreholes); now these households can enjoy spring water daily. This has improved household's physical access to water.

Our interviewees expressed a strong preference towards spring water. Spring water is generally perceived to offer superior quality compared with other water sources (i.e. the MWC's piped water service, shallow groundwater, and surface water). As shown in Table 6.1, spring water delivered through individual connections and from communal tanks has a lower coliform faecal count compared to piped and well water (Iqbal et al., 2015). As a householder put it, "now, we can use (spring) water for drinking. We cannot do that with water from our well". More than 70% of interviewees drank spring water, while piped water and water from shallow dug wells was mainly used for non-drinking purposes.

Our findings also suggest that the presence of a network of spring water allows households to access safer water at a cheaper cost compared to previously available sources. Individual or shared spring water connections had the lowest initial charges compared with piped water or the construction costs associated with boreholes or dug wells (see Table 6.1).

Table 6.1 Cost estimates and potability of different water sources.

Water source	Initial cost in IDR 1000	Cost per litre, in IDR 1000	Monthly cost, in IDR 1000	Average faecal coliform concentration in water samples, in MPN
Metered piped water from the MWC	739-750	0.01	50-120	190.1
Boreholes	2500-11,500	N/A	N/A	9.4
Dug wells	500-2500	-	-	420.0
Individual spring water connection	200	-	15-50	5.8
Shared spring water via communal tank	200-237	N/A	20-50	
Spring water bought with buckets from communal tank	-	0.15	N/A	
Branded bottled water	40	6	70-170	9.4
Refilled bottled water	35	1	26-50	145.2
Pushcart vendor	-	1	50-200	7.5

Notes:

- Costs were estimated based on the information obtained from the interviews with households and local contractors in Ujungberung District.
- The average monthly household income of participants is IDR 3,000,000.
- N/A=Data not available
- Participants could not provide an estimate of the monthly cost of a borehole, but we suggest it may be significant if the energy cost of water pumping is considered.
- Data on coliform concentration are taken from Iqbal et al. (2015). MPN=Most Probable Number. The water quality record does not differentiate between the type of spring water connection. For drinking water, faecal coliform concentration must be 0 (Ministry of Health, 2010).

Water extracted from an individual borehole of at least 60 meters depth was perceived as an ideal, yet expensive and often unaffordable, solution. Well operations also lead to energy costs that result from the use of extraction pumps and other costs are incurred due to the construction of storage facilities. Spring water users were charged the lowest monthly payment compared to piped water users and users of water provided by private vendors. Hence, affordability of access to water has been improved by the provision of spring water. On the other hand, the water cost gap still persists between those with access to the spring water network and those who rely on spring water sold by vendors. "It (the spring water connection) is cheap, actually. Imagine if we had to buy water in jerrycans. It costs IDR 1500 for a small one, ten jerrycans cost IDR 15,000 and that is not even enough for bathing".

Following the improvement of physical access to better quality and more affordable water supply, we then discuss which actors contribute to these improvements (see Figure 6.4). In the early establishment of the spring water businesses, community actors came to an agreement with spring owners who expect them to distribute some water for the local communities if they continue to sell water to areas outside Ujungberung District. Since citizens hold more power to bargain, the power

relationship that exists between citizens and local private actors is different from that existing between citizens and large private companies, like in Jakarta, or state-owned companies. A formal permit is issued by local administrators when entrepreneurs intend to establish business activities. Refusal to save water for local people may jeopardize the sustainability of water entrepreneur's business. A local chief suggested:

> *"If they want to build a business, they need our permission. Our regulations forbid anyone to commercialise water, but it is happening. The entrepreneurs have invested so much in the creation of reservoirs, a network system, and in tankers. They need to sell water. If we act there will be no water for sale. So we keep quiet, we need water, too. What's important is that there is no clash between the entrepreneurs and the people. We could've played rough, but we understand each other."*

Multiple actors jointly contribute their inputs particularly in the distribution chain. A spring owner also confided, "It's hard to build a business in the middle of a place like this, let's just say that we are vulnerable. If we don't provide water, although we lack it sometimes, it won't be good for us. At least we have each other's back". Even so, we found other pangkalan who do not allow community to tap from their springs, and still, the threat of business termination has never materialised.

On the other hand, the community's supply of water depends on the sustainability of water entrepreneurships. If the commercialisation of spring water did not take place, the community may not be able to enjoy the spring water. The local community does not have any financial means to bring water from the springs to people's premises. A senior member of the community put it as follows: "it takes a lot of money to build a network to deliver water from the springs to the second reservoirs. Trucks are also needed to bring water from the reservoirs. Trucks also cannot run by themselves, fuel and drivers are needed, hence, money". The senior community member later emphasised that "it is a business, but otherwise, people in Ujungberung District would not have clean water".

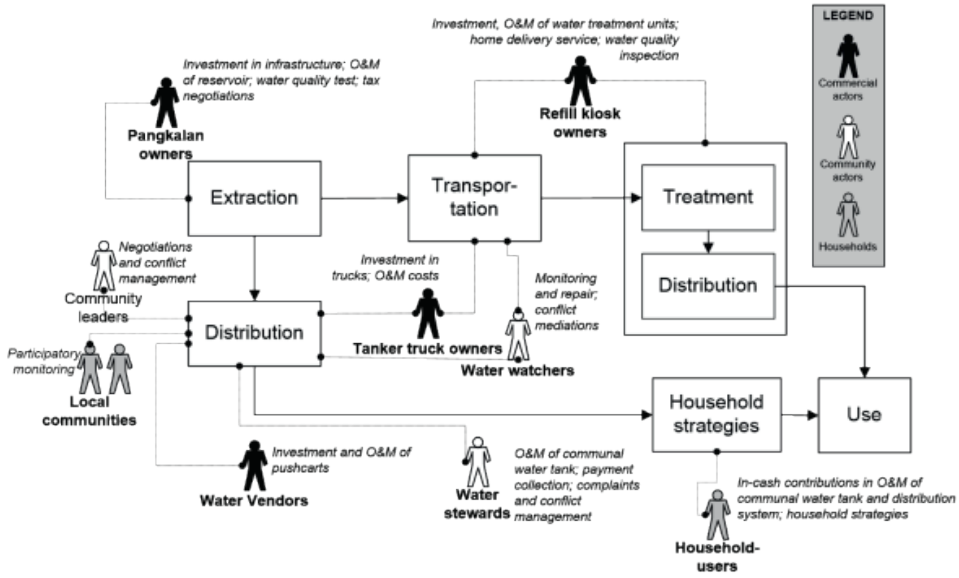

Figure 6.4 The actor and input diagram in the value chain of commercialised spring water in Ujungberung District.

Private actor's investments and operations are mainly driven by the profit motive and the need to sustain business activities. Spring owners/operators strived to attract new customers but kept loyal customers by applying many strategies. These range from setting up a negotiable and competitive selling price, ensuring good water quality through a well-maintained distribution network, to promoting the results of water quality testing. The refill kiosk owners interviewed avoid using groundwater or piped water as raw water sources, and instead opt for spring water that has a good reputation for quality. Additionally, refill kiosks gain customer's loyalty by maintaining their treatment efficacy, and in some cases using water-quality testing certificates to promote their products. To some extent, these business strategies result in indirect effects (externalities) that lead to improvements in physical access to the network of spring water and an accompanying safer and/or more affordable supply compared to other water sources.

Apart from the contributions of co-production to the improvement of physical access, quality, and affordability, we observed that cooperation between local entrepreneurs and community members extends to conflict management. This was articulated by a local chief when discussing water as a source of conflict, "water is hot, even if it is actually cold". Potential sources of conflict relating to equity are water disruption, free-riding behaviour, and inequalities in the geographical distribution of services.

Water Disruption Problems. Households connected to individual spring water supplies are serviced continually, although households sometimes suffered from low water pressure. However, households that rely on communal tanks experienced frequent water disruption, particularly during dry periods. Although households using spring water and piped water supplied by the MWC experienced similar problems of poor daily and seasonal continuity, households preferred the spring water source. During the dry season, or when demand is high, the spring owner is often unable to

provide sufficient water to supply both businesses and households at the same time. Ujungberung District is famous for its mountain water. Therefore, commercial and industrial clients of spring water entrepreneurs are spread throughout the city and over neighbouring regencies. Water must be delivered by tanker trucks beyond the district limits to these commercial and industrial clients. These types of clients benefit local entrepreneurs rather than household or communal users primarily because they buy water in large quantity per trip and pay in higher prices.

Minor unrest and distrust are sparked when entrepreneurs are accused of prioritising commercial and industrial clients, while local entrepreneurs claim that they never actively reduce the supply to the local community. Such conflicts are managed by local chiefs and water stewards. Their presence, and the social relationships between actors, help bypass the traditional complaints procedure. Households convey their complaints to local chiefs, who are responsible for immediately conveying complaints to operators of spring water. If the problem lies in the distribution system between the spring water reservoir and the communal tank, for example due to damaged pipes, households, together with local water stewards and local chiefs take collective responsibility for repairing the network or paying for repairs. In this way problems have a greater chance of being resolved rapidly.

Free-riding behaviour and participatory monitoring. In the late 1980s, a state-led piped water service supplied clean water to communities in the Ujungberung District. At that time, raw water sources were bought from natural spring sources owned by members of the local community. The piped water service was stopped to some areas, three years after the MWC began their operations. A senior community member suggested that the short life of the MWC service in certain areas was mainly driven by the occurrence of massive and illegal water tapping. As a senior community member recounted, "the officers monitored the reservoir… but they did not monitor the network rigorously. People began stealing water. There was no water. It took so long for the water to flow. The water was taken all the way along. People drilled the pipes, like woodpeckers". At present, spring owners face similar, yet less significant, problems. Some illegal actions occurred during times of water shortage. People siphoned water by perforating plastic pipes and diverting water to their dwellings without permission, often using mechanical pumps. Identifying evidence for water theft was straightforward, particularly during the rainy season because (1) water flow rate suddenly decreased; or (2) the water turns murky because contaminants were sucked into the system through punctures.

These problems are mitigated by some forms of participatory monitoring. Spring owners are negatively affected by deteriorations in water quality and reduced water flows that result from illegal tapping. Therefore, spring owners work hard to alleviate illegal tapping at the point of extraction and transportation. Households become aware of occasional water theft when there is a sudden decrease of water pressure. Households contribute to monitoring at the point of distribution by reporting leakage occurrences to water stewards or network watchers, who then investigate the distribution hoses. Network watchers voluntarily monitor the distribution system and local people report occurrences of damage within the spring water distribution network. A water committee member confided:

Now our watchers monitor. People also monitor the water, should such things (illegal tapping) happen, they get annoyed. We know exactly which hose goes to which

neighbourhood. If parts of the network pass along a motor taxi terminal, the drivers will tell us. If parts of the network run through a small shop, they will tell us.

In the past, some conflicts arose around the use of the communal spring water tank. Water is scheduled to be delivered to a certain neighbourhood for three hours a day, for example from 7 a.m. to 10 a.m. After 10 a.m.; the valve supplying that neighbourhood is closed, and water is diverted to another neighbourhood. Incidences of flow being diverted to neighbourhoods which were not scheduled to receive water at that time outside the allocated period have occurred. Again, the watchers are tasked with preventing such occurrences.

Geographic distribution of service. Individual and shared access to the network of spring water are confined to locations where gravity allows water flow. Networks of spring water use rubber or plastic hoses, which are more vulnerable than the PCV, asbestos or iron pipes used by the MWC. Even so, hoses are preferable to other type of pipes due to the flexibility of hoses. The network of spring water is often sighted at unprotected locations, such as the roadside. The durability of these hoses is hence reduced when greater lengths are used, in term of the susceptibility to frequent damage by traffic. We found communities located in this 'technical outreach' of the network of spring water are not served by such a system. Our interview revealed that there was a shared consciousness that "not all can get water from the communal tank" and that "the water won't be enough". To further reduce the conflicts between those who receive spring water service and those who do not, the water stewards determined the monthly fees of IDR 300,000. This fee is collected from the households using spring water service and paid to the pangkalan owners. However, pangkalan owners do not press people to pay this fee. Water stewards and senior community members insisted on setting this fee. This monthly fee was not the price of water nor the price of water distribution. It was rather 'the price of peace'. A high fee would lead to protests from local people who feel they were entitled to a water supply, while supplying the water for free would trigger protests based on social envy from those who are unable to access spring water.

6.7 Discussion

6.7.1 Private actors and co-production

This study highlights co-production occurring within the value-chain of commercialised spring water. Commercialising of spring water started to occur when local entrepreneurs identified a gap in the market for drinking water supply left by the state that provided an inadequate service for all citizens in Ujungberung District. An example of commercialising of water in South Africa suggests that disengagement of citizens is worsened and access to water services by poorer people is reduced (McDonald and Ruiters, 2005). Our findings demonstrate that private control over natural water sources stimulates institutionalised co-production arrangements and institutional innovations, which further leads to an improved access to a safer and more affordable water supply, and nurture equity. Cooperation between private and community actors demonstrates its effectiveness at reducing tension between market-based provision and added value for the public (Bovaird, 2006).

This study analyses the cooperation and experiences of private actors, households, and community actors, that Pestoff and Brandsen (2010) refer to as the "third sector", in co-producing spring water supply services. The term co-production is

commonly used to describe the arrangements in which services are jointly produced by state agencies, citizens, and communities only (Brandsen & Honingh, 2015). However, the involvement of private parties in co-production activities is referred to in public-private partnership arrangements (Klijn & Teisman, 2005). The concept of co-production, or co-creation, is also found in the relationships between private service providers and their clients in service-based industries (Auh et al., 2007; Ordanini & Pasini, 2008; Voorberg et al., 2014).

We argue that the case of spring water distribution in Ujungberung District is a form of co-production since this arrangement displays the characteristics of co-production described by Boyle and Harris (2009) who identify primary producers and users/communities as both co-planners and co-deliverers of services. Aside from any one or the elements of the service production process being shared, co-production is further defined by: (1) the presence of a fundamental shift in the balance of power between the primary producers and users/communities, and (2) the existence of mutual support and relationships networks rather than a clearly defined delineation between providers and clients (Boyle and Harris, 2009).

In the planning phase of water distribution system, private actors and the third sector negotiate the extent and means by which spring water can reach the community. In the service delivery phase, private actors (spring owners) provide the water while the community actors including water stewards, water watchers, and local chiefs maintain the sustainability of spring water delivery via the distribution network. Lastly, households individually contribute to improvements in the quality and continuity dimensions for water services they receive. Inconsistent supply and water quality problems are mitigated through home strategies such as water treatment and storage and by giving feedback regarding service quality addressed by community and private actors.

We have observed a fundamental shift in the balance of power among actors. When spring water was given based on neighbourly relationships, users relied on the generosity of spring owners who provided free water. With respect to the state-led piped water service, there is a sense that the MWC exerts authority over their clients, reflected in a lack of action in response to customer's demands for service improvements (Nastiti et al., 2017). This example of co-production extends beyond "volunteers ministering to ever more passive needy individuals on the fringes of public services, whilst the professionals continue with business as usual" (Boyle & Harris, 2009: 17). Users positioned at the receiving ends of the water service are motivated to assist in the provisioning of spring water by establishing water committees which regulate water allocation at distribution points or, at the very least, report service quality problems and leakages within distribution networks. This is similar to what Alford (2014) described when referring to the role of building occupants in providing early notification to the fire department when fire occurs.

As previously described, the size of the water entrepreneurships, the requirements for local permits, and the social relationship between private and community actors shift the balance of power of primary producers away from private actors to the community. The practices of the MWC are defined strictly by typical state provider and client relationships, in which the installation of new connections, the submission of complaints, monitoring of meters, and all other regular activities of water provision are conducted through formal means and procedures. Our interviewees suggested

that the MWC retains all control over their provision of water. In contrast, the relationships of local private actors with the local community are based on informal agreements and social relations, thus giving room for grassroots negotiations and reducing communication barriers. Contrary to a typical provider and client relationship, the co-production arrangement in the Ujungberung District promotes partnerships between the private sector and the community.

"the relationships of local private actors with the local community are based on informal agreements and social relations, thus giving room for grassroots negotiations and reducing communication barriers"

Ostrom (1996: 1074) argued that the major examples of infrastructure such as water and sanitation works are "not where one would first look to find important, replicable examples of effective co-production". Our case study of the Ujungberung District indicates that the provision of spring water characterised by co-production makes up a third of water used by households we interviewed. The contributions of different actors stimulate improvements in the overall quality of water supply service. Our findings show that there are improvements in the physical access, quality and affordability dimensions of water service because of institutional innovations. These innovations manifest themselves mainly in the distribution chain because of cooperation between local private actors and community actors, i.e. through negotiation, participatory monitoring, and conflict management.

Pestoff & Brandsen (2010) argued, however, that innovation alone is not sufficient as it must also be accessible to a broad range of users. This emphasises the equity issue in service improvement. Although in general the co-production processes in the Ujungberung District have improved access to water for the previously unserved by piped water and boreholes, had given the opportunity to negotiate from below, and yield in a more transparent and accountable provision, we showed that the impact of co-production is in line with the particularistic nature of the third sector, where the benefits of improved quality of the water service are restricted to a group of users (Pestoff & Brandsen, 2010). In our example, groups with geographical advantages in relation to the spring water service, those with the financial means to provide their own spring water connections, and neighbourhoods able to effectively negotiate with local entrepreneurs benefited over others. Despite the remaining inconsistent service coverage, co-production has led to the introduction of viable options for increased access to clean spring water for previously unserved households.

To further understand and better manage co-production arrangements, Alford (2014) suggests a classification for co-producers that focuses on service outcomes rather than just service outputs. In the case of Ujungberung District, the co-production process is not limited to the output of consistently supplying good quality water to consumers. It also includes the outcomes of safeguarding public health and general well-being, and reducing conflicts among neighbourhoods which may occur in association with commercialised spring water. The motivations of local private actors in co-production activities are characterised mainly by profit and business sustainability, while the motivations of community actors gravitate towards maintaining peace and reducing tensions and conflicts in the district, while household users expect to receive access to a clean, adequate, and affordable water supply that promotes health and productivity. For the co-production process to thrive, positive relationships between actors with different motivations are essential.

Therefore, the act of negotiation, and the cultivation of transparency and accountability are required. We suggest that the acknowledgement of each co-producer's motivations, and an understanding of how these motivations regulate the co-production arrangement are vital to optimise the co-production process.

6.7.2 The policy implications of co-production within commercialised spring water

While we found that co-production processes within commercialised spring water might indeed improve access to water, concerns over the presence of capitalistic entities in basic infrastructure service remain. These concerns gravitate not only in a worry that the prime economic motives of these entities may someday trump the social aspect of water, but also on the potential problem of excessive extractions which may lead to the degradation of spring water resources. We then place the discussion within the broader spectrum of water governance by focusing on the role of the state and the current legislative framework in mitigating these disasters.

By law, raw water abstraction for commercial purposes is permitted based on commercial water rights, an instrument to limit the volume of water that can be extracted by permit holders. If enforced properly, such an instrument was expected to prevent ecological problems caused by excessive extractions. The newly enacted Drinking Water Bill 122/2015 further implies that any business with water as commodity intended to be produced not for the sake of self-sufficiency, violate this Bill. At the city level, the licensing instrument is still in place: every person or entity that performs groundwater and surface water extraction, including pangkalan, requires a Water Extraction Permit (WEP) from the Mayor (Government of Bandung City, 2002). WEP holders are also required to pay a levy based on the volume of water they extract. Failure to fulfil these obligations leads to a forced suspension of business activities, but we found partial enforcement of this legal obligation in which not all pangkalan operate legally with a WEP. We estimate that the amount of tax is 1.25 times higher than the maximum gross monthly revenues of a pangkalan. The high cost of formalisation discourages pangkalan to legally register their activities with the city, making it difficult for the government to control the volume of water extracted by these entities.

The new 122/2015 Drinking Water Bill also mentions that state organisations shall be given priority to manage and provide water supply services. The current mayor of Bandung City, Ridwan Kamil, had requested to acquire privately owned springs for public company's raw water supply. Out of 400 springs located in Bandung City, only 70 are in operation for public use. This brings us to the discussion of re-municipalisation as a form of government intervention that sheds light on the debate of public-private ownership in water provision service. The recent debate in the international and national communities are whether to formalise the informal water provision or heighten the role of the public sector through, perhaps, a re-municipalisation (Valdovinos, 2012). We suggest that the success of re-municipalisation and its effect on water market depends on the acceptance or willingness for the community to embrace water provided by the public sector, which is known to be unreliable. A separate study in our case study area demonstrates that a loss aversion behaviour of a perceived poor service quality may demotivate households to connect even when households have the sole authority to decide and are given options to connect (Nastiti et al., 2017).

6.8 Conclusion and recommendations

We conclude that rather than making a distinction between state or market provision, water supply management incorporates a broad spectrum of provision structures. Private sector involvement does not necessarily lead to less equity in terms of: (1) improved access to water; (2) the opportunity to negotiate from below; and (3) transparency and accountability. However, this will depend on the presence of effective local community actors. Institutional innovations established in the co-production process in the Ujungberung District, Bandung have yielded a safe and affordable water supply service for citizens who previously had no access to piped water or boreholes in the district. Multiple case comparisons are required to confirm the generalisability of our results to all private/citizen co-productions, and will further increase understanding of this particular institutional arrangement. Findings in Greater Jakarta provide an example of a similar supply system where spring water is delivered by trucks. Similar communal provisions were also found in other peripheral areas of Bandung. Further research is needed to fully understand how this type of co-production arrangement may contribute to larger-scale urban water planning. Additional research should be conducted to analyse how changes in the local institutional framework of urban water management can further improve such co-production arrangements.

"..water supply management incorporates a broad spectrum of provision structures."

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Notes:

1. A local chief is a neighbourhood head appointed by the community members. A local chief is responsible in assisting public service activities and bridging the communication gap between the government and the community.

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Chapter 7

Synthesis and Conclusion

This dissertation analyses and describes the multifaceted access of the urban water supply sector in the Indonesian regions of Bandung and Jakarta. The daily realities of citizens with the urban and peri-urban areas of Bandung City with regards to securing water – as well as how they perceive those realities – have been examined. A special chapter (Chapter 4) on bottled water as the most popular source of drinking water is also presented by including perceptions from bottled water users in Bandung and Jakarta. It is very likely that our findings with respect to citizens' experiences and perceptions may be relevant for many cities in developing countries, as related experiences had been documented before (e.g., see Spencer [2008]). Therefore, we have elaborated a generic framework of water supply provision (Figure 7.1).

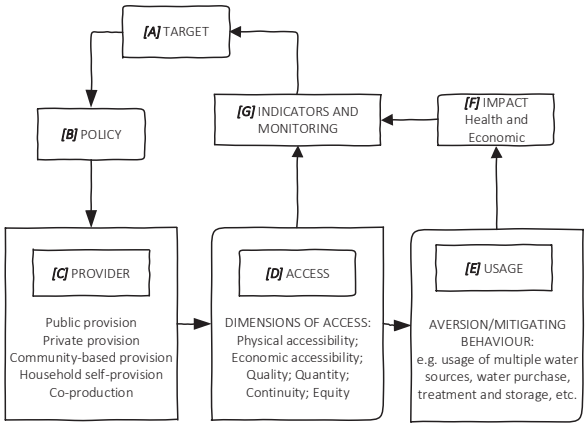

Figure 7.1 A more detailed framework of water supply provision, which was previously shown in Figure 1.1 (Chapter 1). Based on goals to be achieved by the water sector (A and B), countries strive to provide drinking water to citizens through various institutional arrangements. Part C shows the range of water supply service providers –public or private providers, individual households, or combinations of different actors. These providers produce outputs in the form of a physical facility providing water; "access" comes with equity issues and various ranges of quality, quantity, continuity, and price (D). Countries often monitor the performance of the water sector, mainly through the level of access to these physical facilities (G). However, access in the urban areas in many developing countries is multifaceted. Even though households may have access to these physical facilities, it may be insufficient due to the dimensions of. Citizens often adopt a broad range of individual and collective strategies to improve the dimensions of access, which are often referred to as "aversion" or "mitigating behaviours" (E). Access (and its dimensions) may expose urban citizens to various health and economic risks related to water. The economic and health impact of water supply (e.g., diarrhoeal diseases and excessive water expenditure) is mediated through aversion strategies (F). Access, dimensions of access, and aversion strategies make up the daily water realities for many of the citizens in urban areas of developing countries.

This chapter is organized as follows. Section 7.1 dissects the notions of "access" versus "multifaceted access" in the water supply sector. To do so, examples of

users' behaviours in Chapter 2 to 5 as well as experiences with co-production described in Chapter 6 are drawn to the discussion. The main findings are related to the lessons learned from the Millennium Development Goals (MDGs)' previous water supply monitoring approach. Next, Section 7.2 discusses a monitoring approach that should be able to better cope with the complexity of "multifaceted access". This chapter ends with the general conclusion of this dissertation as well as scientific and practical recommendations for researchers and policy-makers alike (Section 7.3).

7.1 Beyond access: taking into account the dimensions of access, user perspective, development outcomes, and provision structure

Between 1990 and 2015, 2.6 billion people gained access to improved drinking water sources; the rate is more striking in developing regions in which there was a 60% increase within 12 years (UNICEF & WHO, 2015; WHO & UNICEF, 2014). Despite the major achievement of the MDGs' water targets, critiques generally argue that what had been the strengths of MDGs can also be perceived as their weaknesses. As reported by United Nations (2012), the MDGs' narrow focus on certain fields shifts attention from other important development elements. For example, in the health field, the Indonesian Ministry of Health conducts an annual survey of Basic Health Research. In 2007, the survey did not measure diarrhoea and was only designed to measure malaria, TB, and HIV, which are three diseases targeted to be reduced in the MDGs. This is in contrast with the fact that diarrhoea is the third cause of death (for communicable diseases) among the national population of all ages and the number one cause of death among children under five years old in Indonesia (Ministry of Health, 2011). Moreover, the UN report also mentions that the shared common vision of MDGs often undervalues countries' contexts and differences in baseline conditions and thus became the "one-size-fits-all" solution. In the context of target 7c of the MDGs (i.e., to halve the population without access to safe and sustainable water sources), the Joint Monitoring Programme (JMP) employs the notion of access based on the availability of certain technologies that supposedly protect water from contaminations and provide "improved" water supply as a proxy for "safe" water. Indeed, the emphasis on simplified indicators provided policymakers with a robust approach in measuring progress that is internationally comparable, but they simultaneously ignored the complexity of poverty and development problems (United Nations, 2012).

"The emphasis on simplified indicators provided policy makers a robust approach in measuring progress that is internationally comparable, but they simultaneously ignored the complexity of poverty and development problems." (United Nations, 2012)

***Firstly,* the simplified notion of "access" to an improved water source, which supposedly serves as a proxy for safe and sustainable water, fails to draw the link between physical access and the dimensions of access**. According to Clasen (2012), such a simplified notion was never designed to capture the core component of the MDGs' water target. Water is a basic need that means to protect people's health, to uphold their dignity, maintain their quality of life, and in a broader framework, to serve as a pre-requisite towards a sustainable development. In order to ensure that water supply provisions provide intended health and economic impacts, the dimensions of access, safety, quantity, continuity, and affordability needs to be taken into account. However, this research suggests that improved water sources often have problems in at least one dimension of access. For

example, there is no significant difference in microbial quality between improved and unimproved water sources in the Ujungberung District, suggesting that the former is not necessarily safer to consume than the latter (see Chapter 3).

Another example is piped water supply. Development experts generally agree that, by far, centralized piped water is the most efficient technology to provide water for urban communities. The Association of Indonesian Drinking Water Operators launched a "10 million home connection" program. However, the significance of having piped water at home is reduced when the network does not work properly. Chapter 2 demonstrated that only 30% of piped water users in slum households in Bandung have a 24-hour supply. Therefore, these people are forced to store water or use other sources. When the reliability of supply is jeopardized, the cost of obtaining adequate water supply for daily needs will pose high costs to households (see Chapter 5).

Interestingly, findings from the field suggest that citizens perceived piped water to be the unwanted choice of access to water, despite the fact that "piped water" sits in the top of the Joint Monitoring Programme (JMP)'s drinking water ladder. The findings from Chapter 3 suggest that households did not perceive piped water as the most superior form of provision. Thus, the position of piped water in the drinking water ladder is trumped by other sources that households deem to be safer, cheaper, or, in general, better in either one or more dimensions of access. Thus, the expansion of piped water access needs to be accompanied with its improvement. The 2015 Drinking Water Bill emphasizes the importance of these improvements by stating, "the aim of drinking water provisions are among other to achieve the accessibility of drinking water …. and a decent and affordable water supply service" (Government of Republic of Indonesia, 2015). Even so, this is not yet taken into account in the national and local monitoring framework.

"The position of piped water in the drinking water ladder is trumped by other sources that households deem to be safer, cheaper, or, in general, better in either one or more dimensions of access."

***Secondly*, the narrow focus on "drinking water" does not consider the full feature of "domestic water" supply.** Such a confined focus had gained attention of the sector towards the health aspect of water for drinking purposes, and thus "... has muted attention to the wider consideration of domestic water and its impact on livelihoods and poverty" (Goff and Crow, 2014, p.159). Therefore, it is not surprising that research is more focused on the quality dimension of water. In practice, however, households separate water for specific use with different quality requirements (see Chapter 2, 3, and 5). For households interviewed in this study, "drinking water" only means one of these sources: bottled (or refilled) water, boiled water, or, in the highly exceptional case, spring water without boiling. Households commonly have a strict distinction between water for drinking purposes and water for non-drinking purposes based on the perceptions regarding which source is safe to consume. Often, "safe" lies in the eye of the beholder: households depend on their sensory perceptions to decide whether water is safe to use or consume. For drinking, the perception of risk associated with water quality and aesthetic performance (e.g., smell, colour, and taste) are more important than other dimensions of access (see Chapter 3).

This research argues that water for non-drinking purposes should gain similar attention as that for drinking purposes. For non-drinking purposes (e.g., bathing, washing, toilet flushing), adequacy in quantity and continuity are perceived to be more important than potability. The high volumetric needs for hygiene purposes also suggest that affordability needs to be taken into account. It was often found during fieldwork that households not only have a different source of water for drinking and other domestic purposes but that they also obtain water for non-drinking purposes from different sources. Chapter 3 shows that this is related to the issue of various dimensions of access. For instance, the quantity problem is represented when the main source of water cannot provide enough water, and the affordability problem manifests itself when dependence on the main source of water is too costly for households. As Spencer (2008) argues, water with lower quality might well satisfy daily water demand of poor urban dwellers as long as it is also lower in price. As observed in Chapter 3, households in Ujungberung opt to use spring water they buy from vendors together with water from their shallow wells. Using water sold by vendors for all domestic activities creates a high cost burden; thus, households continue to use shallow groundwater with a poorer quality compared to better quality purchasable water for bathing and washing activities.

Emphasizing both drinking water and domestic water supply is not important in countries where potable water is available continuously in reliable quantities from the tap. However, this is very much an issue in Indonesia, in which both the terms of "drinking water" and "clean water" are recognized—and are sometimes interchangeable—in the water sector policy. The 2015 Drinking Water Bill defines "drinking water" in a stricter characterization as a household water source that meets the health requirements, with or without treatment process, and is suitable for direct drinking purposes (Government of Republic of Indonesia, 2015). The National Ministry of Health requires drinking water to be of a certain level of quality that is safe to consume; for example, it must contain no levels of faecal coliform (Ministry of Health, 2010). In reality, it is rarely found that water coming out from the faucets are completely free from faecal coliform and are acceptable in the context of other physical and chemical parameters, nor it is expected to be so in the near future. It is admitted that there is a glaring gap between the quality of existing "clean water" sources and the "drinking water" requirements (R. Soebandi, personal communication, July 8, 2014). The Water Quality Requirements Bill Number 416 Year 1990 defines "clean water" as water for daily needs in which its quality meets health requirements after boiling (Ministry of Health, 1990). Thus, "clean water" indicates the source of "raw" water, and "drinking water" indicates the "point-of-use" for drinking. Bandung City uses the term "clean water" and "drinking water" interchangeably in the Regional Mid-term Development Plan 2013-2018 of Bandung City (Government of Bandung City, 2014).

The confusing mixed use of the concepts of "drinking water" and "clean water" for other domestic purposes proved to be misleading in monitoring. Chapter 2 mentions that the National Statistical Office changed the way a "water supply" is classified. Before 2011, households were classified as "improved" if their main drinking water sources originated from improved sources. Since 2011, households are classified as "improved" if water sources used for bathing/washing activities originated from improved sources. Consequently, this shift caused a seemingly increasing trend in coverage for improved water supply. Moreover, the concept of "drinking water" in the MDG target indicates the *point of use* rather than the *source of water,* because JMP

also includes “cart with small tank or drums” and “tanker truck” as the source of water (Bartram et al., 2014). Nevertheless, the national monitoring framework measures the source of water despite the way water is obtained (National Statistical Office, 2016). For example, a household buying resale piped water from vendors is still counted as having access to piped water. Since 2008, fortunately, the national survey had differentiated these two types of access to avoid over-estimation of in-house piped water supply coverage. For other types of water, this blurred difference is still a statistical problem—for example, because households buy protected spring water from vendors.

Thirdly, **the aggregated coverage of access masks the disparity between groups.** Inequity within different geographic areas—urban-rural, intra-urban, and quintiles—persist and sometimes have increased (WHO & UNICEF, 2014). Some critics argue that governments and donors have picked off the low hanging fruit by only reaching the most accessible people, consisted with populations with larger incomes and higher sociodemographic status (House of Commons of United Kingdom, 2011). The examination on differentiated access is a topic of growing scholarly concerns, particularly within the context of inter-socioeconomic classes, inter-gender, and interspatial variations (Birkenholtz, 2013; Crow & Sultana, 2002; Sultana, 2007). Chapter 5 demonstrates that a glaring inequity of access to water persists within Cikapundung households with different economic levels; higher income households are more likely to have access to piped water compared to their lower income counterparts. Onda et al. (2012) indicate that despite the astonishing increase in coverage, an additional 1.2 billion people still use water from sources or systems with significant sanitary risks. As shown in Chapter 5, households in better economic status can afford and tend to spend more for water, and thus these households are better protected from the risks associated with poor water supply through more advanced treatment and strategies. Thus, the future water supply framework should not only address the inequity of access but also the inequity of burden related to obtaining water (e.g., time and cost burden).

Fourthly*, *information on provision structure is absent. Since having access to a water supply (along with sanitation) has been considered as a basic human right, governments are subsequently held responsible for fulfilling the rights of their citizens in obtaining such a basic need. In this accountability context, one piece of crucial information is missing from the current monitoring tools: the record of who provides access to safe and sustainable water supply. As previously discussed, present monitoring relies solely on the indicator of physical access. For example, the level of access to water in Bandung City is roughly 70% by 2012, with only 25% of the total population relying on the municipal water network, albeit this is inconsistently reported (Government of Bandung City, 2014). It is unclear how many of the remaining 45% of the population with access to an improved water source obtain their water from the state-led provision system. Findings from the field suggest that self-provision, very often coupled with a community-led or private-led provision, remains the main mode of access to a water supply. For this reason, this section discusses some legal and policy issues in regard to the provision structure.

a. Individual measures in securing water safety and sustainability

   A number of international reports have been addressing issues regarding individual household modes in achieving the desired level of water safety and

reliability from a water supply. For example, UNICEF & WHO (2011) reported a high level of individual measures securing water safety and reliability through household filtration and storage. From a health perspective, the filtration strategy has been crucial in protecting public health in relation to poor water quality (Fewtrell & Colford Jr., 2004). However, it is argued that promoting a prolonged adoption of household water treatment and storage may shift the responsibility of water provision to the hands of citizens. In the case of home water treatment, Schmidt and Cairncross (2009) warn that "…local or national governments of low income countries may use the promotion of home water treatment to actively or inadvertently divert attention from failures in public water supplies. Water may be seen as a household problem rather than a public good for which governments have a clear responsibility…" (pp.988). Schmidt and Cairncross (2009) also state that home water treatment may divert household income and time or effort away from other productive activities. In Bandung, boiling water is the most widely adopted home water treatment. This activity imposes households with fuel costs and time and effort to do so, but most of the households use bottled water to avoid boiling. Bottled water costs at least 30 times higher compared to using public piped water. Moreover, as demonstrated in Chapter 5, the users' efforts in dealing with the poor reliability dimension of access is significant and may increase almost one-third of water expenditures among poor households rather than when they use public piped water services exclusively. Strategies such as home water treatment and storage are seen as temporary solutions, and they are expected to fade once a "better" form of water provision arrives. UNICEF & WHO (2011) emphasized that these strategies are a stopgap measure only and do not replace the obligation of a service provider to provide access to safe drinking water.

Another significant example of individual measures in obtaining a reliable water supply is groundwater abstraction. Deep groundwater is highly regarded among the participants of this research. However, the use of this water source apparently exposes households to considerably high costs, which is often unobserved, compared to the costs in accessing public water provision. Moreover, there is a concern of ecological sustainability in excessive groundwater abstraction, particularly those performed by individual industries to fulfil water needs for production purposes. In Bandung, groundwater abstraction is permitted based on commercial water rights. Although this legislative instrument aims to limit the volume of water that can be extracted by permit holders, the net result of the extracted water enhances land subsidence in the Greater Bandung area (Abidin et al., 2008).

b. Private-led water supply provision

The private sector has been a highly significant provider of both drinking water and water for any other domestic purposes. This significance is supported by the fact that current national monitoring has included water vendors and bottled water as an important source for accessing water. However, the position of this type of provider in the regulatory framework is contentious. The national debate over the role of the private sector in water supply management came to the surface years before the Water Resource Law of 2004 was finally withdrawn on February 18th, 2015 as a result of a verdict handed down by the Constitutional Court in 2013. At that time, public attention was largely focussed on the

concession contract of piped water services—for example, the involvement of Palyja and Thames PAM Jaya (now AETRA) in Jakarta's piped water supply service. However, the annulment has been suggested to have contributed to restraints on the expansion of bottled water companies, particularly Aqua-Danone (Constitutional Court, 2013). Following the retraction of the former Water Resource Law Number 2004, which was considered as putting too much favour to the privatization of water, the 2015 Drinking Water Bill was enacted (Government of Indonesia, 2015). This 2015 Bill limits the role of the private sector in water supply provision. The explanation section of the 2015 Drinking Water Bill mentions the verdict of the Constitutional Court that states that water shall be managed by the State in a manner that the responsibility of water management has to be prioritized to the central government or local government providers. Only when there is no public provided service in an area can community groups and business entities produce their own water for *their own consumptions* of business activities. Furthermore, any private activities with regard to drinking water services can only be achieved through public-private partnership schemes under these two principles: (1) a water extraction permit must be owned by the public agencies, and (2) such provisions must prioritize low-income citizens. The scope of cooperation allowed in such schemes include the following: (1) investment in raw water extraction and water production units; (2) investment in distribution units, which will be further operated by the public agencies; (3) investment in operation and maintenance technologies following a performance-based contract mechanism. Therefore, there is no legal basis for small-scale private providers that sell to a large number of consumers nor for large bottled water companies to operate.

Even so, this research clearly shows that private providers indeed play a great role in providing services for those underserved by the public sector. Whether these types of provisions are in violation of the existing water supply regulations is another matter. Two examples are given clearly in this research: commercialized spring water in the Ujungberung District and bottled water. It appears that the spring water commercialization in the Ujungberung District, as discussed in Chapter 6, violates the clauses incorporated in the 2015 Drinking Water Bill since the water extraction permit is owned by the local entrepreneurs, and most of the water extracted from the natural spring is sold to the large consumers. Even so, local entrepreneurs, together with local community actors and households have formed an institutional arrangement under the scheme of spring water commercialization and co-production, which has led to a more effective provision model. Shutting down the spring water business because their activities are in violation with existing regulations may negatively affect hundreds of people that rely on the supply of clean water through the communal spring water network.

In the context of bottled water,[i] the annulment of the former Water Resource Law of 2004 aims, among other things, to limit the environmental and social conflicts that have occurred between bottled water companies and citizens (Prasetiawan, 2015). Supporters of the annulment believe that the Water Resource Law of 2004 allowed a high degree of private sector involvement in water resource management affairs, including drinking water provisioning but failed both to limit private sector activities and identify those accountable for any negative externalities occurring due to these activities.

By default, the old Watering Law of 1974 was re-enacted as the primary legal reference for all water resource affairs (Government of Indonesia, 1974). The Watering Law of 1974 is deemed to insufficiently regulate water resource affairs that have occurred over the last four decades, particularly the issue of private sector participation. In the wake of this judicial vacuum, some actors have been concerned with the absence of a "legal framework" for commercial water use permits that are not yet in place. Actors argued that "there was no longer a mechanism with which regional governments could grant concessions to companies that required water in their production cycles, potentially shutting down operations" (Salim, 2015). It is feared that a judicial vacuum may entail closure or stoppage of business operations. However, the Watering Law of 1974 does not completely forbid private sector involvement in drinking water provisioning. Clause 11 Verse (2) of the Watering Law of 1974 states that legal establishments, social establishments, and individuals performing water commercialization should obtain permits from the government; thus, the annulment does not fully delegitimize the role of the private sector. Indeed, the annulment was considered premature since there was no instrument that could fully replace its juridical position, except for the older Watering Law of 1974. The revocation of the law implies invalidation of derivative regulations and contracts or other legal documents that are attached or based on the annulled law, including the Drinking Water Bill 16/2005. The new Drinking Water Bill 122/2015 does not refer to the bottled water industry, but it implies that any business that produces water as a commodity not intended for its own use may be in violation of the bill, including businesses within the bottled water industry.

Despite this, bottled water companies have not stopped retail operations and instead readjusted their businesses in terms of production and distribution to accommodate change (Salim, 2015). In fact, there has been an 11.5% increase in bottled water sales in the first quarter of 2015 in comparison with the same period last year (Dewi, 2015). Additionally, a new regulation on water resource commercialization was introduced in December 2015, which is the same year in which the annulment of the Water Resource Law of 2004 occurred. Thus, the apocalyptic scenario in which the present legal institutions threaten the existence of the bottled water industry, thus leading to a drinking water crisis, has never materialised. As demonstrated in Chapter 4, if anything, bottled water has successfully gained consumers' trust and loyalty, and consumers consider this form of access as inseparable from their daily lives. Similar to commercialized spring water, shutting down bottled water businesses will affect thousands, even millions, of people who rely on such a product for access to drinking water.

Moreover, there is a general perception among public officers at the national level that the use of bottled water is an indicator of the failure of the drinking water provision system in Indonesia (A. Nasution, personal communication, July 25, 2016). This perception, however, may not be similar to what is believed by water-related authorities in the lower level. A personal communication with a city's public officer revealed that there is a perception that the responsibility of the local agencies merely rests in providing "clean water", and the people's demand to "drinking water" is achieved through bottled water sale (Anonymous, personal communication, 18 December 2012). This dualistic perspective of bottled water is also similar to that of the individual household strategy: the rising familiarity with bottled water shifts the responsibility of providing drinking water

from public companies to private bottled water producers and demotivates public companies for taking immediate action to improve and maintain the quality of piped water.

Despite the critiques to the approach in measuring physical access, as discussed above, the JMP had laid an important foundation to better understand the water supply sector in the developing countries. The drinking water ladder concept clearly indicates that there are different "levels" of service. The JMP's drinking water ladder determines what the minimum acceptable level of service is and what the highest level of service is to be achieved. In the Indonesian context, the regulation mentions the notion of the Minimum Service Standard, which is a minimum requirement of types and quality of basic services that citizens are entitled to obtain (Government of Republic of Indonesia, 2015). There are two types of drinking water supply: network and non-network. Networked water providers need to ensure the quantity for basic needs, regulation-conforming quality, and 24-hour continuity of drinking water (Government of Republic of Indonesia, 2015). Thus, the dimensions of access have at least been accommodated under a regulatory framework, in which the providers are obliged to meet the so-called the Minimum Service Standard. Yet, water providers in many Indonesian cities are struggling to comply with this standard. For example, only 30% of piped water users have access to a 24-hour supply of water (Chapter 2), but piped water exposes users to higher infection risks related to the microbial quality of water compared to refilled water (Chapter 3). Recognizing the different levels of service does not necessarily mean that the highest level of service needs to be achieved straight away, but it is important to admit that physical access reflects the minimum level of service to further move towards improvement. As Thomas (2006) stated: "the real value of performance measurement and reporting comes … by helping to frame questions and to structure a dialogue about how to improve public services" (pp.2).

Moreover, it is important to note that when the MDGs were created (as well as how they will be monitored), access to a water supply (along with sanitation) was yet to be officially recognized as a human right. Since 2010, United Nations officially recognizes that access to a water supply is a human right, in which quality, continuity, quantity, and affordability criteria are implied. Thus, any water target developed after the MDGs were agreed to be aligned with the criteria of human rights to water. Consequently, the future monitoring framework for measuring the performance of the water supply sector needs to address the limitations mentioned previously. Failing to recognize the dimensions of access, the full features of a domestic water supply, the issue of equity, and the provision structure in the monitoring framework may limit the ability of water supply provisioning in achieving health and economic benefits.

7.2 Informing the water sector: monitoring beyond access

The previous section has elaborated how the existing monitoring and legal framework has insufficiently taken into account the concept of multifaceted access in water provisioning of the cities in the developing world. To this point, it is understood that there are different factors related to water (e.g., acceptable quality, sufficient quantities, affordability, reliability) that can be counted as having access to improved water sources; yet, these are hardly elaborated in the present monitoring framework. This section intends to further the discussion on how this shortcoming should be

mitigated in the future monitoring framework. Before starting this discussion, I first return to the main goal of monitoring progress and performance.

Progress and performance measurement is commonly used to inform policy. It provides answers to questions such as 'where are we now?'; 'what should be done to achieve an objective?'; and 'how much resources should be allocated to achieve that objective?'. A common catch phrase of "if you cannot measure it, you cannot manage it" has become familiar in the management of public utilities and natural resources. Stone (2002) highlights the dominance of "counting" in measuring problems: "...[t]here is the danger that politicians, public managers, interest groups, the media, and the public at large will become mesmerised by the numbers." (Thomas, 2006). Stone (2002) states that counting begins with categorization: deciding which things are included and which are excluded, which requires value judgment; "…every number is a political claim about where to draw the line" (pp 167). In the water supply sector, local governments desperately need to build a good rapport (e.g., to secure political positions); for example, local governments tend to polish their reports on the coverage of access to water (anonymous, personal communication, July 2012). Thus, the ambiguity of numbers allows for free interpretations.

Within the political domain, categorizing, counting, and finally measuring are issues of framing—that is, determining which fact is relevant and gives meaning to a situation. The inconsistent definitions of "improved access" in Indonesian statistics, as previously discussed, is a prime example of this framing. In the 2011 MDG report, the National Planning Agency decided to revise the coverage of the population having access to improved water sources when it reclassified households using bottled water as "having access to improved water sources" as long as these households use one or more improved water sources for other domestic uses (Ministry of National Development Planning, 2012). Hence, improved access means access to "clean water". This approach has been further used for access measurement since 2011, explaining the sharp increase in improved water source coverage from that year onwards. The National Statistical Office (2015) reported that, by 2013, the coverage of population with access to improved water sources was 73.34%, almost reaching the MDG's target of 75.29%. The same report also states that access to improved water sources has grown with a rate of 7.38% per year. However, the report failed to mention the change in the definition of "improved water sources", which was adopted in 2011.

"Within the political domain, categorizing, counting, and finally measuring are issues of framing—that is, determining which fact is relevant and gives meaning to a situation."

As the MDGs expire, the outcome document of the 2010 High-level Plenary Meeting of the General Assembly on the MDGs requested that the Secretary General initiate a dialogue on a post-2015 development agenda. Critics have argued that the shortcomings that the MDGs have faced could have been avoided if a more inclusive consultation process had taken place during its formulation (United Nations, 2012). In the water sector, after the 2015 agenda, the SDGs (Sustainable Development Goals) highlight the key role of water, sanitation, and hygiene (WASH) in the development framework. It is agreed that in the post-2015 era, the water-related framework should embody the following: (1) be integrated and have a stronger focus on cross-sectoral and stakeholder cooperation; (2) focus on equity by targeting poor

and marginalized groups and neglected areas of development; (3) create incentives and accountability for progressive realisation of the human right to water and sanitation; (4) leave room for flexibility for adaptation to local contexts, needs, and priorities (UN-Water et al., 2015; WaterAid, 2013). Striving to achieve universal access to water and improving service quality, the SDG water framework demands for a more complex monitoring framework and both generalized and localized targets.

Target 6.1 of the SDG on "universal and equitable access to safe and affordable drinking water for all" will still rely on a physical access indicator—that is, the percentage of population using *safely managed* drinking water service. The Government of Indonesia has also conducted a study to assess potential indicators for the SDGs' water target, in which data was obtained from the annual National Socio-economic Survey (SUSENAS). In general, there is no significant difference between measuring the access level with what was adopted during the MDGs. The Government of Indonesia still relies on the concept of "minimum basic service" by defining populations with "access" as those who use water from improved sources that is accessible within 30 minutes per trip. Even so, the study indicated that such an approach has limitations as it does not show the minimum available water quantity. Table 7.1 shows the SUSENAS questions relevant to water supply access.

Table 7.1 SUSENAS questions relevant to water supply access (National Statistical Office, 2016)

- What is the main source of water used for drinking? (branded bottled water, refill water, metered piped water, resale piped water, borehole, protected well, unprotected well, protected spring, unprotected spring, surface water, rainwater, others)
- If the main source of water used for drinking is borehole/well/spring, how far is the source of water to the nearest waste water containment facility? (<10 m, ≥ 10 m)
- Does household own drinking water facility? (Yes for personal purpose, yes shared with other households, public facility, no)
- How does household obtain drinking water? (buying in retail, subscribe to regular deliver, not buying)
- What is the main source of water used for cooking? (branded bottled water, refill water, metered piped water, resale piped water, borehole, protected well, unprotected well, protected spring, unprotected spring, surface water, rainwater, others)
- If the main source of water used for cooking is borehole/well/spring, how far is the source of water to the nearest waste water containment facility? (<10 m, ≥ 10 m)
- What is the main source of water used for bathing/washing? (branded bottled water, refill water, metered piped water, resale piped water, borehole, protected well, unprotected well, protected spring, unprotected spring, surface water, rainwater, others)
- If the main source of water used for bathing/washing is borehole/well/spring, how far is the source of water to the nearest waste water containment facility? (<10 m, ≥ 10 m)
- Does water used for bathing/washing originate from networked piped water or a public water terminal? (networked piped water, public terminal)
- How much money does each household spend for water?

When looking at the list of questions, potential indicators indicating the multifaceted nature of access are available to some extent. Therefore, we propose to build on the existing approach. Below, we formulate three proposals to further improve the national monitoring of water supply access, and we discuss the related challenges.

7.2.1 Integrating "quantitative" and "qualitative" reporting

Thomas (2006) provides two valuable insights to consider when evaluating and designing a future monitoring framework that fits with the situation in the (peri-)urban water sector in Indonesia. *First*, it is crucial to find a balance between quantification versus the qualitative evidence or the "performance story". Although it is easier to focus solely on measuring output "quantity", a failure of measuring "quality" will distort the achievement of outcomes. Firdaus et al. (2012) emphasize that improved sources are not necessarily safe. The poor performance of piped water services and the severity of various environmental problems, including water pollution, expose at least 20% of Indonesia's population to severe health impacts of poor water quality. The United Nations (2013) recognized the urgent need to focus on the quality of public service, including water supply, and that the failure of doing so will lead to an unsustainable provisioning of such a service. Firdaus et al. (2012) further mention that, at present, the reports on water supply access rely solely on quantitative measurements, and there are no comprehensive reports on the real condition of water supply access. The JMP's monitoring model is a valuable starting point in quantifying performance in the water supply sector, but it is important to complement this model with a more detailed performance report and monitoring to provide a more comprehensive picture of Indonesia's water supply sector.

The National Statistical Office (2015) proposes as an indicator to measure the achievement of the SDG water target: the percentage of the population using "basic drinking water" (a modified JMP's indicator). The National Statistical Office uses a different definition of "drinking water" than the definition included in the Drinking Water Bill. "Drinking water" is defined as water used for consumption, food preparation, and other basic purposes, and it must be accessible within 30 minutes from the premises (which includes the time it takes to make a one-way trip as well as time spent waiting in a queue) (National Statistical Office, 2014). National Statistical Office (2015) further proposes to use the term "safely managed" to illustrate the drinking water minimum service standard. This indicator measures a more detailed water supply situation than that of the JMP's by combining the assessment of access and safety of water. Households are considered to have access to "safely managed" drinking water when they obtain water directly from the source and, if necessary, adopt some "necessary steps" to protect the availability and safety of drinking water sources (National Statistical Office, 2015). Nevertheless, the National Statistical Office has yet to specify these "necessary steps", and they also do not specify the parties responsible for performing such steps. The National Statistical Office (2014) also recognized that the indicator does not show the quantity of water available. As Chapter 2 mentions, it does not make sense to classify households that have access to piped water and water is only delivered once every two days as "households with improved sources" since the majority of their water needs are fulfilled through water from vendors or unprotected wells.

Second, it is important to develop a performance measurement system that addresses distributional questions: "who benefits? Who pays" (Thomas, 2006). The United Nations (2013) recognizes that some disaggregated indicators are necessary to measure access. The United Nations (2013) further suggests that the target is only achieved if it is also achieved for all relevant socioeconomic groups. Furthermore, the National Statistical Office (2014) acknowledges the link between accessing piped water, the cost or expenditure related to water, and the equity issue.

The report states that the government should consider the equity aspect—in particular for the urban poor—without putting an excessive financial burden in accessing water. Chapter 5 shows that the real water expenditure, including the mitigating costs to cope with poor supply reliability, ranges between 6.6 to 10% of total household expenditures; this is higher than the donors' rule of thumb that water expenses should not exceed 5% of the total household expenditure. These numbers are expected to be much higher when households rely on water vendors for most domestic activities. Since Chapter 5 also demonstrates that the rate of piped water connections is higher than in high-income groups, it is likely that many other poor households in Bandung bear the high cost of commercial water sold by vendors. Findings from Ujungberung households, as shown in Chapter 3, also suggest that the perception of the high installation costs of piped water hinders households to accept connection; thus, a scheme is needed to ensure that installation costs of a new piped water connection are affordable for all income groups.

7.2.2 Including a user perspective in monitoring

Focusing monitoring on the real performance of the water sector at the point of delivery (e.g., quality, quantity, and continuity of water) is indeed an ideal approach. Such data may be obtained from the utility companies' information systems. But, again, Indonesian cities commonly have low coverage of state-led networked water supplies, and there is a large gap in terms of the information on different dimensions of access. An interview with a water expert revealed that including users' choices and perspectives in the monitoring framework has long been debated because of the issue of accountability. This raises the question to what extent can states be held responsible for providing access to services? Indeed, states are clearly responsible in providing good quality services at the point of delivery, but states cannot force people to use their services. This argument might very well be relevant for countries with a robust state-supplied drinking water service. For example, as discussed in Chapter 4, people's motivation to drink bottled water in the USA and northern European countries are very much different to that of Indonesia. Findings from this research show that different strategies adopted by households are mostly driven by deficiencies in the provisioning system. Thus, user perceptions, measured through a household survey, may serve as a proxy for the real performance of the water supply sector. At the very least, the behaviour of using multiple water sources can be measured from SUSENAS questions with regard to the source of water for different domestic purposes (see Table 7.1).

An important feature of monitoring that has been gaining increasing attention is the idea of involving users through a participatory monitoring approach. Indonesia attempted to apply an MDG measurement through the Joint Report Card, a modification of a citizen report card, in ten provinces (Kemitraan Partnership, 2009). Citizens and government representatives participated in providing perception-based assessments of local government's performance in MDGs achievement through surveys and focus group discussions. The results were combined with the MDGs' city profile to provide a comprehensive information of MDG achievement in the pilot city. Kemitraan Partnership (2009) notes that the application of such an approach calls for several cautions: participants must be carefully selected to avoid bias resulting from participants proximity with local elites, good facilitators with full understanding of the development goals are crucial, and local values and cultures need to be considered when designing the instrument. However, Kemitraan

Partnership (2009) suggests that the Joint Report Card may serve as an effective monitoring tool if performed biennially. This research argues that the future monitoring framework of the SDG water target should rely more on this type of participatory approach, as it has been shown to be possible with the application of the Joint Report Card in ten Indonesian provinces.

7.2.3 Linking output and outcomes in analysing monitoring data

WaterAid (2013) emphasizes the critical linkages between water, sanitation, and hygiene (WASH) and a broad range of human development goals, including health, education, gender equality, environmental sustainability, and employment. It shows the positive impact that improvements in WASH have on these goals and conversely how poor WASH hinders their achievement. As physical access is clearly about output, linking the outcomes with the output is challenging albeit important.

In the context of the health impact of water, linking access, water quality, and health outcomes indeed is an ideal approach. Evaluating the water supply performance through an epidemiologic approach may use a set of tools to assess the actual health risk of a population (Medema & Ashbolt, 2006). By using an epidemiologic approach, one may try to find the correlation between water use and the risk of water-related diseases, which is often represented by diarrhoea or gastrointestinal diseases. Although it sounds reasonable, this approach has some limitations (e.g., sensitivity issues and a poorly developed disease surveillance system). Epidemiology emphasizes the causation concept that addresses multi-factorial causation, confounding, the interdependence of effects, direct and indirect effects, levels of causation, and systems or webs of causation (Rothman et al., 2008). Diseases may be also underreported due to the limited disease surveillance system. This partly explains the findings in Chapter 2, which showed no association between access and self-reported diarrhoea. When one wishes to upscale disease-based monitoring for water supplies, several limitations are apparent. People living in remote areas of Indonesia may have little access to health services, isolating them from the disease surveillance radar. It is also common for diarrhoea patients with no life-threatening symptoms to choose not to go to health centres or seek advice from pharmacies or to simply self-medicate (Brata et al., 2015).

While it is challenging to directly correlate drinking water and the health risk manifested in diseases, end-testing of water quality has long been used as a proxy to represent the health risk faced by the community due to drinking water (Bain et al., 2012; Onda et al., 2012; Shaheed et al., 2014; Yang et al., 2013). However, relying on end-product testing to check the safety of the water delivered to the consumer, where treated water samples are taken for quality analysis and the results are compared with allowable standard, is deemed to be ineffective since it indicates the problems only after they occur (WHO, 2004). End-product testing leads to somewhat inconclusive information to water providers and policy-makers.

The microbial risk-based approach, like what Putri et al. (2015) performed in the Ujungberung District, is extremely useful to pinpoint the prioritization area for improvement along the production chain of water. Despite its valuable role in setting health-based targets, the application of a microbial risk-based approach faces layers of uncertainties, especially if one wants to employ this method in developing countries. QMRA is classically applied for a specific pathogen, but completing a microbial risk-based approach for every pathogen that may be transmitted by water

would be time-consuming (Howard et al., 2006). Moreover, the presence of pathogenic bacteria in water is sporadic and erratic, levels are low, and the isolation and culture of these bacteria are not straightforward, so routine water microbiological analyses do not include the detection of pathogenic bacteria; instead, they use indicator bacteria (Cabral, 2010). The country-wide application may also face several technical, financial, and feasibility challenges. This also applies to a chemical risk-based approach.

As drinking water is closely related to health, the efforts to measure the economic impact of water supply access is mainly related to associated-health costs. Measuring the averted cost of diseases related to water supply access has been frequently done (Haller, Hutton, & Bartram, 2007; Hutton et al., 2007). The direct health-related benefit includes the reduction of disease risk, therefore averting health care cost. However, it must be noted that there are methodological limitations and drawbacks to evaluating associated-health costs. First, the benefits are often underestimated since there are intangible benefits that cannot be quantified and interventions may lead to some externalities. Avoided cost of illness alone does not represent the suffering and long-term impact of persistent diseases to households' quality of life. Moreover, too often, the beneficiaries (i.e., households) do not realize how much resources can be saved by investing in proper water facilities, since avoided health cost is not "the money at hand". This is different with resources saved by investments in drinking water facilities, where households no longer have to spend money on somewhat more expensive water from vendors or bottled water. Second, the relative effectiveness of several interventions cannot be separately estimated when services of water, sanitation, and hygiene are provided together, and this issue will be important in a policy setting since providing a full package may be prohibitively expensive or difficult (Kremer & Zwane, 2007).

We recommend considering, with respect to the aversion costs, not only the costs associated with health but also estimated costs associated with water-related strategies. Although a detailed survey is required, this approach serves as a reliable measure of economic impact related to water supply access and, when coupled with a distributional concern, as a measure of equity. With regard to the practical application, SUSENAS recorded the amount of money spent for water by those buying water or subscribed to a water provider; this could be a potential indicator (see Table 7.1). However, the effectiveness of this indicator remains a question as SUSENAS automatically discharges households that do not buy water in answering the cost question. Thus, aversion costs remain unrecorded and difficult to estimate unless a separate and more thorough survey is created.

Ultimately, it is important to note that any future monitoring tools need to be anchored nationally to ensure their sustainability and to avoid the excessive cost of the monitoring itself.

7.3 Conclusion

The main conclusions of this dissertation are the following:

First, this research demonstrates that the level of access towards improved water sources is overestimated, and households with access to a certain improved water source do not necessarily use such a source on a sustainable basis nor abandon the usage of alternative, unimproved sources. This research provides important insights

that water-related choices of different strategies adopted by households are actually associated with the poor quality (or absence) of water supply services. Moreover, there is evidence that the poor remain excluded from accessing improved water supply sources, particularly piped water networks. These facts are not taken into account in the official performance statistics.

Second, because of the absence of a water supply or the poor quality of an existing supply, households are imposed by costs associated with various strategies for obtaining water or maintaining the service level of water for daily needs, mainly through groundwater extraction. Such costs are often "hidden" but may very well increase household water expenditures significantly when taken into account. At present, cost-benefit analyses of providing safe and adequate water supplies are rooted to healthcare costs avoided from preventing diseases associated with poor water quality, while costs associated with water reliability problems (e.g., groundwater extraction costs when piped water is unable to fully deliver adequate water supply) are less considered.

Third, this research also gives special attention to commercial bottled water. Despite the negative social and environmental impacts, bottled water has become increasingly popular in Indonesia. The poor quality of piped water supplies, in addition to the deterioration of groundwater and surface water sources, encourages people to consume commercial bottled water. The highly priced bottled water is now not only the most trusted and preferred drinking water source, but it is also inseparable from modern life, as it has the appeal of not only good water quality and physical health but also great taste, convenience, mental health, and positive social and environmental values. Debates over bottled water continue: on one hand, the merit of bottled water has closed the gap of drinking water needs that the public sector has been unable to provide; but, on the other hand, the increasing popularity of bottled water is alarming in the way that it may reduce the motivations of public water companies to take immediate actions to improve their water quality.

Fourth, this research also demonstrates a broad spectrum of water provision structures. The water provision structure in many cities in the developing nations is not always marked by a clear distinction between state-, market-, and community-led provisions. This research examined a relatively unknown provision structure that is characterized by co-production between non-state actors. This research suggests that such institutional innovations contributed to a safe and affordable water supply service for citizens who previously had no access to piped water or boreholes in the district.

Finally, this research acknowledges that the current monitoring approach in the water sector has neglected the multifaceted nature of water supply provisioning. The current nation-wide survey has raised many potential water-related questions, which may improve the monitoring of water supplies and their accessibility. I further propose to incorporate the idea of "beyond access"—that is, information related to behavior, impacts, and providers—into a more comprehensive performance monitoring system, which may include composite indices and qualitative monitoring of user perspectives as well as a clearer link between monitored output and outcomes.

Note:

[i] The issues on the legal basis of bottled water industry were discussed together with Indrawan Prabaharyaka dan Teddy Prasetiawan.

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SUMMARY

Coping with the rapidly increasing demand for freshwater services in the vastly growing urban areas has been a vital issue of this century. The cities' water problems are not only about transporting water, but also to ensure that the water supply delivered to urban citizens contributes toward the intended positive personal, social, and economic development outcomes. The water supply sector seems to largely focus on supply-oriented provision through expanding physical access. This research highlights what's beyond physical access to water and reveals the complexity of water provision in urban and peri-urban areas. In this dissertation, physical access to water refers to the classification of the WHO and UNICEF's Joint Monitoring Programme (JMP) –the United Nations' mechanism to monitor progress in the water and sanitation sector. The JMP classifies water supply sources into piped water in premises, other improved sources (i.e., protected dug well, borehole, protected spring, and rainwater harvesting), and unimproved sources (i.e., unprotected dug well, unprotected spring, bottled water, and water from vendors). The present monitoring framework focuses on measuring the level of access: the proportion (un)served by improved water sources. Drawing examples from Bandung City and Jakarta, the overarching goal of this research is to gain a deeper understanding of the complex realities of water provision mechanisms in urban and peri-urban areas, by studying what's "beyond access": the multifaceted realities of water supply provision, from physical access, the dimension of access (water quality, quantity, continuity, affordability), users' perceptual drivers and strategies, impacts of water supply provision, and structures of water provision. This dissertation also discusses the link between these multifaceted aspects and sector monitoring.

Chapter 2 and 3 discuss the relation of physical access, the dimensions of access, and user strategies. Chapter 2 identifies the strategies of slum and riverbank households in Bandung City to secure access to a safe and adequate supply of water. The most commonly adopted strategies include the use of mixed water sources, household water treatment, and home storage. The adoption of these strategies suggests a low trust in improved sources and a compromised safety and reliability of water. While official statistics suggest a high level of access to 'improved' water sources, full-time access to such sources is overestimated. For example, ninety-four percent of slum respondents had access to one or more improved water sources. This number was only six percent less than the 2019 universal access target formulated by the Government of Indonesia. Caution, however, has to be taken when using the access level estimate, which ignores the joint use of improved and unimproved sources by households.

The various strategies adopted by households to cope with risks associated with the poor dimensions of water supply service is subsequently studied further in Chapter 3. These strategies are further mentioned as aversion or mitigation behaviour. Aversion behaviours are the measures the households take today to avoid the uncertainty, potential economic loss, and possible negative health impact on a daily

basis. In this chapter, a qualitative analysis approach is employed to understand how households perceive and seek to reduce risks through different strategies. Households employed various aversion strategies to avoid negative impacts, including being "without water", illness resulting from the consumption of contaminated water, excessive time and energy spent acquiring water, and/or paying too much for water. Households maintain storing and treatment behaviours and use different water sources (or combinations thereof) based on their perception of risks that refer to the different dimensions of access to water. A framework that describes actual risk, risk perceptions and aversion behaviours is developed. Risk perceptions and the adoption of aversion behaviours of varying frequency and intensity are based on a complex interaction between personal and shared experiences that relate to water supply dimensions, socioeconomic characteristics, and social networking.

When discussing access to water in Indonesia, the issue of bottled water is inevitable. Bottled water markets are growing rapidly in urban Indonesia; one can find a range of products from the multi-national brands to the ones available in small refill water kiosks. Chapter 4 focuses on branded bottled water and the perceptual drivers of its consumption. In countries that have established and have been maintaining a robust piped water system, such as North American and developed European countries, bottled water has been perceived to be of better quality than piped water. Some critics believed that bottled water consumption was based on the irrational perceptions of consumers as bottled water was not in any way superior to piped water. However, piped water and bottled water cannot be easily compared in the Indonesian context. Drinking from tap water has never been accepted as the norm as piped water has no guarantee of purity and safety. This chapter attempts to explain the phenomenon of bottled water's rising popularity in Indonesia by focusing on the perceptual drivers of bottled water consumption in Indonesia from the perspective of producers and consumers. The results show that despite the popularity of bottled water, it is considered to be an unofficial "indicator" of the failure of the public water supply system which is not expected to match the quality of bottled water at the point of use in the near future. Even if piped water companies were able to maintain the quality of potable water at the point of use, the substantial marketing efforts of the bottled water industry highlight the appeal of bottled water in regard to, not only good water quality and physical health, but also good taste, convenience, mental health, and good social and environmental values. Despite many negative social and environmental issues associated with bottled water, this commodity is becoming "the" drinking water in Indonesia and is inseparable from modern life.

Chapter 5 shifts the focus by discussing the link between access, different user strategies, and economic impacts. This chapter evaluates access to water and water expenditure across households of different income groups. The result shows inequity in the type of access among different groups in which higher income households are more likely to use piped water, bottled water, or the combinations thereof. Expanding access to piped water indeed closes this equity gap, but special attention must be paid to make piped water connections affordable for the lowest income population. High water cost burden is experienced by lower and higher income households, with access to piped water and bottled water as the most significant predictors for the variance of water expenditure. This study also estimates the 'hidden' mitigation costs of groundwater extraction and water boiling. These costs raise the total costs of

water two- to three-fold. By discouraging the use of groundwater when piped water connection is available, hidden costs related to water can be used to improve drinking water service and groundwater restoration. This chapter further highlights the importance of incorporating mitigation costs when assessing the impacts of poor service quality of water supply towards household water expenditure and affordability.

Chapter 6 connects the types of physical access, the dimensions of access, user strategies, and the structure of water supply provision. In Indonesia, water supply management incorporates a broad spectrum of provision structures. Private providers range from large concession to small-scale providers and in the urban and peri-urban South, small-scale water entrepreneurship is increasingly the ascendant water providers for the underserved poor. Chapter 6 examines a co-production arrangement between private actors, households, and community actors occurring within the framework of a scheme of commercialised spring water in peri-urban Bandung, Indonesia and how such a distinguished provision structure had improved the dimensions of access to water. Actor contributions defined as inputs along the value chain of spring water production were examined. This chapter describes interactions between local private actors and community members in planning, service delivery, and conflict management with respect to disruption of water supplies, free-riding behaviour, and the geographical distribution of services. Chapter 6 identifies several institutional innovations that may yield a safer and more affordable water supply and nurture equity in the sense of (1) improved access to water for the previously unserved people by piped water and boreholes; (2) the opportunity to negotiate from below; and (3) transparency and accountability.

The last chapter provides the link between findings from Chapter 2 to 6 and sector monitoring. Several drawbacks of the current monitoring approach are identified: (1) the simplified notion of “access” to an improved water source, which supposedly serves as a proxy for safe and sustainable water, fails to draw the link between physical access and the dimensions of access; (2) the narrow focus on “drinking water” does not consider the full feature of “domestic water” supply; (3) the aggregated coverage of access masks the disparity between groups; and (4) information on provision structure is absent. To better inform the policy-making processes in water sector, this study suggests to improve the monitoring in water supply sector by: (1) integrating disaggregated “quantitative” reporting and “qualitative” evidences or the “performance story” to provide a more thorough realities in the field; (2) including a user perspective in monitoring through, for example, a participatory monitoring approach (e.g. citizen report card); and finally, (3) linking output (access and the dimensions of access) and outcomes (averted negative health impacts and excessive economic burden) in analysing monitoring data. As a conclusion, this research acknowledges that the current monitoring approach in the water sector has neglected the multifaceted nature of water supply provisioning. I further propose to incorporate the idea of “beyond access”—that is, information related to behaviour, impacts, and providers—into a more comprehensive performance monitoring system.

SAMENVATTING

Het voorzien van de snelgroeiende steden van voldoende en schoon drinkwater is één van de grootste opgaven van deze eeuw. Het probleem daarbij is dat er vooral aandacht is voor de technische aspecten van het transporteren van water zoals de aanleg van de drinkwaterinfrastructuur. Dat het water de consument ook daadwerkelijk bereikt zodat het een bijdrage kan leveren aan de persoonlijke, sociale en economische ontwikkeling wordt onvoldoende of zelfs helemaal niet gemonitord. Het lijkt er op dat overheden en de drinkwatersector zich vooral bezighouden met de uitbreiding van de fysieke drinkwater infrastructuur. Dit onderzoek richt zich op de fase ná de fysieke ontsluiting ("physical access") en besteed aandacht aan de complexiteit van watervoorziening in urbane en peri-urbane gebieden. "Physical access" is een classificatie term van het WHO and UNICEF's Joint Monitoring Programme (JMP) –en wordt door organisaties van de UN gebruikt om mondiaal de beschikbaarheid van schoon drinkwater te meten.

Het JMP kent twee categorieën waarlangs de beschikbaarheid van (drink)water kan worden gemeten: de z.g. "verbeterde bronnen" (waaronder aangelegde waterleidingen in woningen en gebouwen, drinkwaterputten of kwelwater bronnen die van het overige grondwater zijn afgeschermd, opvang van regenwater) en "niet-verbeterde bronnen" (waaronder niet beschermende drinkwaterputten of kwelwater bronnen, gebotteld water en water dat te koop wordt aangeboden).

Het huidige monitoringsinstrument richt zich vooral op de mate van drinkwater beschikbaarheid via "verbeterde bronnen". Het overkoepelende doel van dit onderzoek is om gebruik makend van de casuïstiek van de Indonesische metropolen Bandung en Jakarta (W-Java, Indonesië), een beter inzicht te krijgen langs welke wegen en mechanismen burgers toegang krijgen tot drinkwater. Het gaat dan in het bijzonder om het veelzijdig karakter waarlangs mensen in de dagelijkse praktijk zich toegang kunnen verschaffen tot drinkwater. Daarbij wordt aandacht besteed aan a) de fysieke beschikbaarheid van drinkwater, b) de z.g. "dimensies" van drinkwater beschikbaarheid (waterkwaliteit, waterkwantiteit, continuïteit van de drinkwatervoorziening en de kosten), en c) de perceptie van de consument m.b.t. waterbeschikbaarheid en de verschillende strategieën die de consument toepast om aan drinkwater te komen. Dit onderzoek beschrijft ook de relatie tussen deze veelzijdige aspecten van drinkwater beschikbaarheid en het huidige monitoringsprogramma wat door de drinkwatersector wordt gehanteerd en die verbeterde beschikbaarheid in beeld moet brengen.

Hoofdstuk 2 en 3 richt zich met name op de relatie tussen de fysieke toegang tot drinkwater en de verschillende strategieën die door de gebruikers worden gehanteerd om aan drinkwater te komen. Hoofdstuk 2 identificeert de strategieën die de huishoudens in sloppen- en woonwijken van minder bedeelden op en langs de rivieroevers in Bandung gebruiken om aan voldoende en schoon drinkwater te komen. De meeste strategieën richten zich op het gebruik van meerdere

waterbronnen, de (chemische en fysische) behandeling van water en het aanleggen van watervoorraden. Het gebruik van deze strategieën wijzen op een gering vertrouwen in de acties van de overheid en de watersector om de beschikbaarheid tot schoon en veilig drinkwater snel te verbeteren.

Terwijl de officiële statistieken in Indonesië wijzen dat de meeste mensen beschikking hebben over schoon drinkwater blijkt dat in de praktijk tegen te vallen. Zo gaf bijvoorbeeld 94% van respondenten uit de sloppenwijk aan dat zij toegang hadden tot “verbeterde waterbronnen”. Dit aantal was slechts 6% minder dan de in 2019 door Indonesische overheid gestelde streefwaarde en dus op zich een goede score. Echter, deze door de overheid georganiseerde enquêtes hielden geen rekening met het feit dat vele huishoudens in hun watervoorziening voorzien door een gecombineerde gebruik van verbeterde en niet verbeterde waterbronnen. Deze metingen geven dus een overschatting van het aantal veilige drinkwatervoorzieningen.

De verschillende strategieën die door de consument worden toegepast om het hoofd te bieden aan de risico’s die gepaard gaan met de huidige water voorzieningssysteem (poor dimensions of water supply) is verder geanalyseerd in hoofdstuk 3. Deze strategieën worden ook wel geduid als ontwijkings of mitigatie gedrag. Met “mitigatie gedrag” wordt bedoeld de maatregelen/acties die de verschillende huisgezinnen ondernemen om dagelijks de onzekerheid voor waterbeschikbaarheid, de negatieve economische effecten en mogelijke gezondheidsrisico's te minimaliseren.

In dit onderzoek is een kwalitatieve analyse gebruikt om te begrijpen op welke wijze huishoudens het waterprobleem ervaren en welke strategieën worden toegepast om de risico’s te reduceren. Onderdeel van deze strategieën zijn; tijdelijk geen water consumeren, het accepteren van fysieke ongemakken veroorzaakt door besmet water, veel tijd en energie gebruiken om schoon drinkwater te vinden en het accepteren van een relatief hoog bedrag voor het verkrijgen van schoon drinkwater. Daarnaast worden door huishoudens op verschillende wijzen watervoorraden aangelegd en water behandeld.

In hoofdstuk 3 wordt een kader gepresenteerd dat de actuele risico’s, de perceptie van risico’s door de gebruiker en het mitigatie gedrag beschrijft. De perceptie van de risico’s en de aard van het mitigatie gedrag zijn gebaseerd op een complexe interactie tussen persoonlijke en gedeelde ervaringen gerelateerd aan de “dimensies” van het wateraanbod, de socio economische omstandigheden en het sociale verkeer en netwerken.

Als het gaat om drinkwater beschikbaarheid in Indonesië is het aanroeren van het probleem van (plastic) waterflessen onvermijdelijk. De markt van gebotteld water groeit explosief in Indonesië. Overal zijn (plastic) flessen van grote internationale merken tot de kleine “refill” kiosken te koop.

Hoofdstuk 4 richt zich op de bekende watermerken en de achterliggende motivatie om deze producten te kopen. In het verleden werden in landen die nu een robuuste water infrastructuur hebben zoals Noord Amerika en de West Europese landen gebotteld water van een betere kwaliteit beschouwd dan kraanwater. Inmiddels is aangetoond dat er in deze landen vrijwel geen kwaliteitsverschil is tussen kraanwater en gebotteld water maar dat gaat voor de Indonesische situatie niet op.

In Indonesië is water uit de kraan nooit geaccepteerd als een kwaliteitsnorm voor zuiverheid en veiligheid. Dit hoofdstuk probeert de populariteit van gebotteld water in Indonesië te verklaren vanuit het perspectief van producenten en consumenten. De resultaten laten zien dat de populariteit van gebotteld water in Indonesië beschouwd kan worden als een indicator van het falen van het publieke watervoorziening systeem. Men verwacht dat deze voorlopig niet de kwaliteitsnorm van het gebotteld water zal halen.

Zelfs als de waterleidingbedrijven in staat zouden zijn voldoende waterkwaliteit te realiseren bij de consument dan nog moeten ze opboksen tegen de krachtige marketing motor van industrie die gebotteld water aanprijst als zijnde niet alleen erg gezond maar ook van een betere smaak en gemak. Ondanks dat men zich over het algemeen realiseert dat het massaal gebruik van gebotteld water ernstige gevolgen heeft voor het milieu heeft deze handelswaar een prominente positie verworven in de Indonesische samenleving.

Hoofdstuk 5 analyseert en bediscussieerd de relatie tussen drinkwater beschikbaarheid, de verschillende consument strategieën om aan drinkwater te komen en de economische gevolgen daarvan. In dit hoofdstuk is de mate van drinkwater beschikbaarheid in relatie tot de kosten van verschillende inkomensgroepen in beeld gebracht. De resultaten van het onderzoek laten de ongelijkheid zien tussen de verschillende inkomensgroepen waarbij de hogere inkomensgroepen makkelijker over kraanwater, gebotteld water of combinaties hiervan kunnen beschikken. Het uitbreiden van de kraanwater infrastructuur kan de kloof tussen arm en rijk dichten mits de kosten naar rato worden verdeeld over de verschillende inkomensgroepen.

Zowel de lagere als de hogere inkomensgroepen ervaren de kosten die gepaard gaan met de watervoorziening als “hoog”. De belangrijkste indicatoren voor de variatie in het bestedingsbedrag zijn de kosten die gepaard gaan met gebotteld water en kraanwater.

Deze studie maakt ook een schatting van de “verborgen” mitigatie kosten zoals grondwaterwinning en het koken (steriliseren) van water. Deze aanvullende kosten verhogen de totale kosten met een factor 2 tot 3.

Door het ontmoedigen van het gebruik van grondwater als er een waterleiding infrastructuur is aangelegd kunnen deze extra middelen worden aangewend om de drinkwater service en de kwaliteit van het grondwater te verhogen. In dit hoofdstuk wordt het belang benadrukt om deze mitigatiekosten te incorporeren als er een afweging gemaakt moet worden tussen extra infrastructurele investeringen en het bedrag dat de consument nu kwijt is om aan schoon drinkwater te komen.

Hoofdstuk 6 verbindt de verschillende typen van fysieke drinkwater beschikbaarheid, de verschillende dimensies van drinkwater beschikbaarheid (continuiteit, kwaliteit), consument strategieën en de structuur van de watervoorziening. Indonesië maakt gebruik van een breed spectrum van watervoorzieningstructuren. Private partijen variëren van grote concessiehouders tot kleinschalige providers. In het urbane en peri-urbane zuiden, worden de kleinschalige ondernemers steeds belangrijker voor de minder bedeelden.

In dit hoofdstuk wordt een co-productie arrangement rondom een bronwater exploitatie in het peri-urbane gebied van Bandung (W-Java, Indonesië) beschreven en hoe dit arrangement de drinkwatervoorziening heeft verbeterd. De betrokkenheid van de verschillende actoren langs de waardeketen van deze bronwater exploitatie zijn in kaart gebracht. Daarnaast worden de interacties tussen lokale private en andere maatschappelijke actoren beschreven met betrekking tot planning, drinkwaterlevering en conflictmanagement (zoals bij onderbrekingen van levering, free-rider gedrag en de actieradius van levering).

Hoofdstuk 6 identificeert ook de verschillende institutionele innovaties die mogelijk een veiliger en beter betaalbare water voorziening opleveren en tegemoetkomen aan een meer faire behandeling als het gaat om 1) verbeterde toegang tot drinkwater voor de minder bedeelden, 2) de gelegenheid om ook bottom-up te kunnen onderhandelen over de prijs en 3) transparantie en accountability.

Het laatste hoofdstuk brengt de bevindingen van de hoofdstukken 2 tot 6 tezamen en de betekenis daarvan voor het huidig monitoringsysteem van de drinkwater sector.

Er worden verschillende nadelen van het huidige monitoringssysteem in beeld gebracht: 1) het overgesimplificeerde begrip “drinkwater beschikbaarheid” (access); 2) de nauwe focus op “drinkwater” waarbij voorbij wordt gegaan aan de verschillende aspecten van de bevoorrading van huishoudelijk water; 3) de aggregatie van waterbeschikbaarheid waardoor de ongelijke verdeling tussen maatschappelijke groepen wordt gemaskeerd en 4) het ontbreken van informatie over de bevoorradingstructuur van drinkwater.

Om het beleidspoor in de water sector beter te kunnen bedienen worden in dit manuscript een aantal aanbevelingen gedaan om het huidig monitoringsinstrument te verbeteren. Deze zijn: 1) het integreren van kwantitatieve data met kwalitatieve gegevens van veldinterviews die meer informatie geven over de daadwerkelijke performance; 2) beter gebruik te maken van het gebruikersperspectief door het aanwenden van bijv. “participatory” monitorings technieken en tenslotte 3) het verbinden van “output” (drinkwaterbeschikbaarheid en de dimensies daarvan) met “outcomes” (het afwenden van gezondheidsproblemen en toenemende kosten) bij het analyseren van monitoringsdata.

Dit onderzoek (“beyond access”) heeft aangetoond dat het huidig monitoringssysteem van de water sector voorbijgaat aan het veelzijdige karakter van (drink)watervoorziening en meer informatie met betrekking tot gedrag, effecten en typen providers nodig is om zo tot meer realistische schattingen te komen hoeveel en in welke mate consumenten toegang hebben tot schoon en veilig drinkwater .

RINGKASAN

Salah satu tantangan terbesar abad ini adalah mengatasi tekanan akibat pesatnya peningkatan permintaan akan air bersih di daerah perkotaan. Permasalahan air di daerah perkotaan tidak hanya sekedar berkutat pada bagaimana memindahkan air dari sumber yang jauh hingga ke tangan konsumen, namun juga bagaimana memastikan agar air yang diterima oleh masyarakat dapat berkontribusi terhadap dampak pembangunan personal, sosial, dan ekonomi yang positif. Sektor air minum tampak lebih menitikberatkan penyediaan berorientasi suplai melalui peningkatan akses fisik semata. Sebagai contoh, target Dekade Air Minum dan Sanitasi pertama diterjemahkan oleh sebagian besar lembaga sektoral sebagai mandat untuk membangun sistem baru sebanyak-banyaknya. Penelitian ini menekankan pada aspek-aspek yang lebih dalam dari akses fisik air minum dan menjabarkan kompleksitas penyediaan air minum di daerah perkotaan, termasuk peri-urban. Dalam disertasi ini, definisi akses fisik air minum mengikuti klasifikasi air minum yang dikeluarkan oleh *Joint Monitoring Programme* (JMP) WHO dan UNICEF, yang merupakan mekanisme Perserikatan Bangsa-bangsa untuk memantau kemajuan di sektor air minum dan sanitasi. JMP mengklasifikasikan sumber air minum menjadi akses pipa di dalam tempat tinggal, air minum layak lain (sumur gali terlindungi, sumur bor, mata air terlindungi, dan air hujan), serta air minum tidak layak (sumur gali tidak terlindungi, mata air tidak terlindungi, air minum dalam kemasan, dan air minum dari pedagang eceran). Kerangka pemantauan air minum saat ini berfokus kepada pengukuran tingkatan akses melalui besarnya proporsi populasi yang terlayani atau tidak terlayani oleh sumber air minum layak. Dengan mengambil pengalaman dari Kota Bandung dan Jakarta, tujuan besar dari penelitian ini adalah untuk mendapatkan pemahaman yang mendalam mengenai kenyataan kompleks dari mekanisme penyediaan air minum di daerah urban dan peri-urban. Penelitian ini mengupas "*beyond access*", yaitu sistem penyediaan air minum yang bersifat multifaset, mulai dari akses fisik, dimensi akses (kualitas, kuantitas, kontinuitas, dan keterjangkauan), persepsi dan strategi pengguna, dampak penyediaan air minum, dan struktur atau kelembagaan system penyediaan air minum. Disertasi ini juga mendiskusikan keterkaitan antara aspek multifaset tersebut dengan pemantauah sektor.

Bab 2 dan 3 membahas hubungan antara akses fisik, dimensi akses, dan strategi pengguna. Bab 2 mengidentifikasi strategi yang diadopsi oleh rumah tangga pemukiman kumuh dan pemukiman bantaran sungai di Kota Bandung untuk mendapatkan akses air minum aman dan cukup. Strategi yang paling banyak diadopsi adalah penggunaan air berbagai sumber, pengolahan air skala rumah tangga, dan penyimpanan air rumah tangga. Hal ini mengindikasikan adanya tingkat kepercayaan yang rendah terhadap sumber air minum layak dan buruknya tingkat keamanan dan keandalan air minum yang ada. Meskipun angka statistik resmi menyatakan bahwa tingkat akses terhadap air minum layak cukup tinggi, namun persentase rumah tangga yang dapat menggunakan sumber air minum layak

sepanjang hari dan sepanjang tahun lebih rendah dari yang tercatat. Sebagai contoh, sembilan puluh empat persen dari responden rumah tangga pemukiman kumuh memiliki akses terhadap setidaknya satu jenis sumber air minum layak. Angka ini hanya kurang enam persen dari target akses universal 2019 yang dicanangkan oleh pemerintah Indonesia. Namun, penggunaan estimasi tingkat akses perlu diperhatikan mengingat penggunaan sumber air minum layak dan tidak layak dalam satu rumah tangga kerap diabaikan.

Berbagai strategi yang diadopsi oleh rumah tangga untuk menghindari risiko terkait buruknya dimensi air minum dibahas lebih lanjut pada Bab 3. Strategi-strategi ini kemudian disebut sebagai perilaku menghindari risiko atau perilaku mitigasi. Perilaku menghindari risiko merupakan upaya-upaya yang dilakukan oleh rumah tangga saat ini untuk menghindari ketidakpastian, potensi kerugian ekonomi, dan kemungkinan dampak negatif kesehatan sehari-hari. Pada Bab ini, pendekatan analisis kualitatif digunakan untuk memahami bagaimana persepsi dan upaya rumah tangga untuk menghindari risiko. Rumah tangga melakukan berbagai strategi untuk menghindari dampak buruk, termasuk berada dalam keadaan tidak memiliki air, penyakit akibat mengkonsumsi air terkontaminasi, energi serta waktu berlebihan yang dikeluarkan untuk mengakses air, dan/atau membayar terlalu mahal untuk air. Rumah tangga menerapkan penyimpanan dan pengolahan air dan menggunakan berbagai sumber air berdasarkan persepsi mereka megenai risiko terkait berbagai dimensi air minum. Sebuah kerangka yang menjelaskan hubungan antara risiko aktual, pespesi terhadap risiko, dan perilaku menghindar risiko dikembangkan dalam disertasi ini. Persepsi terhadap risiko dan adopsi berbagai perilaku menghindar risiko dalam berbagai frekuensi dan intensitas terbentuk berdasarkan interaksi kompleks antara pengalaman personal dan pengalaman bersama mengenai dimensi air minum, karakteristik sosio-ekonomi, dan hubungan sosial.

Ketika mendiskusikan akses terhadap air minum di Indonesia, maka isu air minum dalam kemasan (AMDK) tak terhindarkan. Pasar AMDK tumbuh dengan pesat di daerah perkotaan di Indonesia, dimana berbagai produk AMDK dapat ditemukan, mulai dari AMDK bermerek multinasional hingga air minum isi ulang yang diproduksi oleh kios-kios kecil. Bab 4 membahas khusus mengenai AMDK bermerek dan persepsi yang mendorong tingginya tingkat konsumsi produk tersebut. Di negara-negara yang telah memiliki dan memelihara sistem air minum yang mumpuni, seperti negara-negara maju di Amerika Utara dan Eropa , AMDK disinyalir memiliki kualitas yang lebih baik dibandingkan dengan air minum perpipaan. Namun, beberapa pihak mengkritisi hal tersebut dengan menyatakan bahwa konsumsi AMDK lebih berdasarkan persepsi irasional konsumen dan bahwa AMDK tidak lebih baik dalam aspek apapun dibandingkan dengan air minum perpipaan. Dalam konteks Indonesia, air minum perpipaan tidak dapat dibandingkan begitu saja dengan AMDK. Mengkonsumsi air keran secara langsung bukanlah suatu kebiasaan mengingat air perpipaan tidak memiliki jaminan keamanan dan kemurnian. Bab ini berupaya memahami fenomena meningkatnya popularitas AMDK di Indonesia dengan membahas aspek-aspek persepsi yang mendorong konsumsi AMDK dalam perspektif produsen dan konsumen. Hasil penelitian ini menunjukkan bahwa kepopuleran AMDK mengindikasikan gagalnya sistem penyediaan air minum yang dianggap tidak akan mampu menyaingi kualitas AMDK di titik konsumsi dalam waktu dekat. Meskipun pada akhirnya, perusahaan air minum perpipaan di Indonesia kemudian mampu menyediakan air siap minum di titik konsumen, upaya pemasaran yang intensif dari industri AMDK membuat produk ini lebih menarik, bukan saja

dalam hal kualitas air yang baik dan kesehatan jasmani, namun juga dari segi rasa, kenyamanan, kesehatan mental, dan nilai-nilai sosial dan lingkungan positif. Meskipun AMDK kerap diasosiasikan dengan dampak sosial dan lingkungan yang negatif, komoditas yang bersifat enigmatif ini telah menjadi air minum utama di Indonesia dan tidak dapat dipisahkan dari kehidupan modern.

Bab 5 menitikberatkan pada keterkaitan antara akses, strategi pengguna, dan dampak ekonomi yang ditimbulkan. Bab ini mengevaluasi akses air dan pengeluaran rumah tangga untuk air pada berbagai kelompok pendapatan rumah tangga. Hasil penelitian ini menunjukkan bahwa ketidaksetaraan akses air minum masih ditemukan dimana rumah tangga yang berpenghasilan lebih tinggi lebih cenderung untuk memiliki akses terhadap air minum perpipaan, AMDK, atau kombinasi air minum perpipaan dan AMDK. Peningkatan akses terhadap air minum perpipaan tentu akan menutup kesenjangan ini, namun tingkat keterjangkauan air minum perpipaan khususnya bagi masyarakat berpenghasilan rendah perlu diperhatikan. Beban biaya yang tinggi dialami oleh baik rumah tangga berpenghasilan lebih tinggi dan lebih rendah, dimana akses terhadap air perpipaan dan AMDK merupakan prediktor penting dari varians pengeluaran akan air minum. Penelitian ini juga mengestimasi beban biaya mitigasi yang tersembunyi, yaitu biaya yang keluar akibat praktik ekstraksi air tanah dan merebus air minum. Biaya mitigasi ini akan meningkatkan beban pengeluaran terhadap air sebanyak dia hingga tiga kali lebih tinggi. Dengan menekan praktik ekstraksi air tanah ketika akses air perpipaan tersedia, biaya mitigasi ini dapat dialihkan untuk membiayai layanan publik untuk pengembangan tingkat akses dan perbaikan kualitas akses serta memperbaiki fungsi ekologis air tanah. Bab ini lebih lanjut menggarisbawahi pentingnya untuk memperhitungkan biaya mitigasi dalam kajian dampak buruknya pelayanan air minum terhadap pengeluaran rumah tangga untuk air dan keterjangkauan air minum.

Bab 6 menghubungkan jenis akses fisik, dimensi akses, dan struktur penyediaan air minum. Di Indonesia, pengelolaan air minum mencakup spectrum struktur penyediaan yang sangat luas. Penyedia air minum swasta yang beroperasi mulai dari konsesi besar hingga penyedia skala kecil. Di daerah urban dan peri-urban di bagian dunia belahan Selatan, pengusahaan air minum skala kecil merupakan penyedia air minum yang dominan, khususnya bagi masyarakat miskin yang tidak terlayani oleh sistem penyediaan air minum publik. Bab 6 mengkaji sistem ko-produksi antara penyedia swasta, rumah tangga, dan aktor-aktor masyarakat dalam kerangka mata air terkomersialisasi di daerah peri-urban di Kota Bandung. Penelitian ini juga mengkaji bagaimana struktur penyediaan yang telah terbentuk berkontribusi dalam meningkatkan dimensi akses. Kontribusi dari aktor-aktor yang terlibat dalam sistem ko-produksi ini didefinisikan sebagai input dalam rantai nilai produksi air dari mata air. Bab ini menjelaskan tentang interaksi antara aktor-aktor pengusaha lokal dan anggota masyarakat dalam hal perencanaan, penyediaan, dan manajemen konflik akibat terputusnya suplai air minum, perilaku menumpang bebas (*free-riding*), dan distribusi geografis akses air minum. Bab 6 mengidentifikasi sejumlah inovasi kelembagaan yang menghasilkan penyediaan air minum yang lebih aman dan lebih terjangkai serta memupuk kesetaraan dalam hal (1) meningkatkan akses air minum bagi masyarakat yang belum terlayani oleh air minum perpipaan dan tidak memiliki sumur bor; (2) memberikan kesempatan untuk bernegosiasi dari bawah ke atas; serta (4) mendukung terbentuknya transparansi dan akuntabilitas.

Bab terakhir membahas keterkaitan antara temuan-temuan penelitian yang disampaikan pada Bab 2 hingga Bab 6 dengan pemantauan sektor. Beberapa kekurangan dari pendekatan pemantauan yang dilaksanakan saat ini kemudian diidentifikasi: (1) penyederhanaan konsep “akses” air mnum layak yang seharusnya menjadi proksi air minum aman dan berkelanjutan gagal menarik hubungan antara akses fisik dan dimensi akses; (2) fokus “air minum” yang dangkal tidak mempertimbangkan fitur lengkap penyediaan “air domestik”; (3) cakupan akses teragregasi menyamarkan kesenjangan akses antar berbagai kelompok masyarakat; dan (4) informasi mengenai struktur penyediaan tidak tersedia. Agar proses pengambilan keputusan dalam kebijakan lebih berbasiskan informasi, maka penelitian ini menyarankan untuk memperbaiki sistem pemantauan pada sektor air minum dengan: (1) mengintegrasikan sistem pelaporan “kuantitatif” terdisagregasi dengan bukti “kualitatif” atau “cerita kinerja” untuk memberikan gambaran yang lebih nyata di tingkat rumah tangga; (2) memasukkan aspek persepsi pengguna dalam pemantauan, misalnya melalui pendekatan pemantauan partisipatif (contoh: kartu pelaporan masyarakat); dan akhirnya, (3) mengkaitkan luaran (akses dan dimensi akses) serta hasil (dampak negatif kesehatan dan ekonomi yang berhasil dihindarkan) dalam menganalisis data pemantauan. Penelitian ini menyimpulkan bahwa pendekatan pemantauan yang ada saat ini belum mempertimbangkan karakteristik multifaset dari penyediaan air minum. Penelitian ini lebih lanjut menyarankan untuk memasukkan ide “*beyond access*”, yaitu hal-hal terkait perilaku, dampak, dan struktur penyediaan air minum, dalam sistem pemantauan yang lebih komprehensif.

DANKWOORD

When I was a little girl, my family and I used to drive at night in our old pickup truck to fetch water. We brought plastic containers, filled it with water from a public reservoir, put the containers in the back of our truck, and drove back home. We had a piped water connection at home but it rarely gave us water on daily basis. During an interruption, the only way to get water for our basic daily needs was to fetch it ourselves. Almost twenty-eight years later, as a middle-class family living in the periphery of metropolitan Bandung, getting water for us is no longer a physical struggle; it is rather a matter of affordability as water becomes part of our domestic budget.

Despite the advancement in water purification and distribution technologies, why is the progress of Indonesian piped water supply network expansion so slow? Why does not everyone have affordable and safe water at home? Why do some people sacrifice more in fulfilling their daily water needs? Does our government lack financial, technological, or human resources to provide water? Does the right rule exists or do we simply play the game wrong? Thus, I started my PhD journey with these questions in mind. My research indeed has not provided answers to all these complex questions yet, but this research is a start to open a new research approach in the Indonesian drinking water sector, which is based on a paradigm that technological fixes alone are not a panacea for all the water problems in the Indonesian society. The main lesson I have learned during my PhD is that in order to overcome the so-called “wicked” water problems, a multidisciplinary, cross-stakeholder approach is crucial.

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ABOUT THE AUTHOR

Anindrya Nastiti was born on October 17th, 1984 in Bandung, Indonesia. In 2006, she completed her bachelor degree in Environmental Engineering at the Institut Teknologi Bandung (ITB) with her final *scriptie* focusing on safety and risk assessment in the food industry. She received her master degree from Institut Teknologi Bandung (ITB) concentrating on Environmental and Occupational Health, particularly human health risk assessment in 2009. Her final master thesis focused on the manganese exposure to welders working in the informal sector.

In 2013, she started working as a faculty member in the Faculty of Civil and Environmental Management, Institut Teknologi Bandung (ITB). She is currently a part of the Environmental Management Technology Research Group. She has been teaching in the bachelor and master program of Environmental Engineering and the bachelor program of Environmental Infrastructure Engineering ever since.

In 2011, she started her PhD journey at Institut Teknologi Bandung first, under the supervision of Dr. Barti S. Muntalif, Dr. Dwina Roosmini, and Dr. Arief Sudradjat. She then entered the double degree program with Radboud University since 2014, under the supervision of the Dutch supervisors: Prof. A.J.M. Smits and Dr. Sander Meijerink. The doctoral double degree program is the first ever implemented in ITB and initiated by the Alliance for Water, Health, and Development: a framework for collaborative research and PhD education between ITB, Radboud University, Universitas Padjajaran, Van Hall Larenstein University of Applied Sciences and Deltares. With her experiences in the double degree program, she decided then to pursue interdisciplinary research in the intersections of environment, health, economics, and human behaviour. She started a website dedicated to cross-stakeholders and interdisciplinary discussions on interscientia.org.